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Technical Report No. 169

A continuous assimilation trial for the Limited Area Model

by

O M Hammon, C A Wilson, D Robinson and R S Bell

July 1995

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A CONTINUOUS ASSIMILATION TRIAL FOR THE LIMITED AREA MODEL.

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1. INTRODUCTION

The regional limited area model (LAM) used operationally currently has an intermittent assimilation cycle, being re-initialised every 12 hours from the continuous global model assimilation cycle (**Fig 1.1**) . The mesoscale model has its own continuous assimilation cycle with the background fields provided by the previous run, and the only coupling to the LAM is through the lateral boundary forcing. It would therefore be more consistent to make the LAM cycle continuous and independent, except for the coupling to the global model through the boundaries. This would allow the retention of smaller scale features by the LAM, which are not resolved at global resolution and have to be "spun-up" in the assimilation at present. Another potential advantage is greater consistency between the main runs at 00 and 12 UTC and the intermediate runs at 06 and 18 UTC; at present there are only two 3 hour assimilation cycles for the latter compared to 12 hours (4 cycles) of assimilation for the former. Other problems such as the mismatch between the global and LAM land/sea masks would also be avoided eg the absence of Cyprus in the global model land mask means that surface variables for the LAM have to be initialised from the nearest land points which are not sufficiently representative.

Making the LAM assimilation continuous would be a further step towards the convergence of the mesoscale and limited area versions of the UM, following the philosophy that the model configurations should only differ when absolutely necessary. Another difference between the LAM and mesoscale model at present is the inclusion of synop data of temperature, humidity and wind over land. These were also included in the LAM tests described below.

It is proposed to start testing the inclusion of satellite derived moisture in the LAM from an enlarged MOPS area later this year. A continuous cycle will allow the retention of the effects of the moisture data which otherwise would be lost through intermittent interpolation from the global model.

A test was carried out to assess the impact of changing to a continuous cycle for the

LAM, as described in section 2 and the appendix. The rest of this note consists of the results and assessment of the trial. A recommendation for operational implementation is made as part of the conclusions in section 6.

2. CONTINUOUS ASSIMILATION CYCLE FOR THE LIMITED AREA MODEL.

A suite of jobs was set up to enable a continuous assimilation (CA) to be run for the LAM model. No observation processing was carried out. The operational observation files and boundary datasets were used. The main difference between the CA and operational suite was the removal of the interpolation from the global main analyses to get the corresponding LAM start analyses. In the CA suite the LAM analyses were continually used in the assimilation cycles. The experimental details of the suite and how to run it are given in detail in the appendix.

A full assimilation and forecast suite was run with 4 forecasts per day at 00, 06,12 and 18 UTC. The main runs (00, 12) included updated intermediate observation files as for the operational system. A daily reconfiguration job updated SST and ice from a separate LAM SST analysis; soil moisture and ozone were also updated daily. The ozone climatology was correctly interpolated to the rotated LAM grid in contrast to the operational reconfiguration from the global model dump which assigns zonal mean values ignoring the rotational grid.

The CA suite started February 20th (12z 19/02/95 analysis). Until March 9th it was run at UM version 3.3 when it was changed to version 3.4 following the operational move to this version on 7 March. Land Synops (surface temperature, 10m winds and RH over land) were included in assimilation from 12z 15th March. From March 17th to March 22nd the assimilation diagnostics switched on (see section 3). The last run of the CA suite was for 12z 12/04/95.

3. ASSIMILATION DIAGNOSTICS

Assimilation diagnostics for the surface and low level radiosondes were examined from 12z 16th March to 12z 21st March. The tables below show (observation-analysis) statistics every 3 hours for the last day of that period. This was typical of the other days. The mean, rms and extreme increments are given together with the position of the observation giving the extreme increment and an observation count. Units are degrees,, m/s and % for the three variables. Tables 3.1-3.3 give statisitics for the synops. Tables 3.4-3.6 give comparable results for the low level radiosondes.

Time & Date	Ob Count	Mean incr	rms	extreme incr	Lat/long of extreme
12z 20/3	2076	0.23594E+00	0.18052E+01	0.10029E+02	44.8N 44.2E
15z 20/3	1847	0.42200E+00	0.18224E+01	0.94133E+01	44.8N 44.2E
18z 20/3	2057	0.10241E+01	0.21204E+01	0.10419E+02	32.8N 359.4E
21z 20/3	1683	0.85456E+00	0.19503E+01	0.78425E+01	42.6N 23.4E
00z 21/3	1763	0.94463E+00	0.19821E+01	0.87378E+01	45.6N 13.8E
03z 21/3	1657	0.66528E+00	0.17648E+01	0.89082E+01	39.3N 352.6E
06z 21/3	2057	-0.67427E-02	0.19145E+01	0.10201E+02	48.7N 358.2E
09z 21/3	1769	-0.35378E+00	0.17726E+01	-0.84068E+01	43.7N 44.7E
12z 21/3	1665	0.14363E+00	0.17783E+01	0.85707E+01	49.8N 295.7E

TABLE 3.1 Synop Temperature (Ob-Anl)

Time & Date	Ob Count	Mean u incr	Mean v incr	rms	extreme incr	Lat/long of extreme
12z 20/3	2210	-0.54139E-01	0.31175E-00	0.35313E+01	0.13584E+02	44.2N 10.7E
15z 20/3	1936	-0.74581E-01	0.70680E-00	0.33350E+01	0.14293E+02	44.4N 9.9E
18z 20/3	2171	-0.22879E+00	0.98274E-01	0.31544E+01	0.11039E+02	44.2N 10.7E
21z 20/3	1751	-0.21902E+00	0.26817E+00	0.30313E+01	0.11490E+02	49.2N 20.2E
00z 21/3	1830	-0.27377E+00	0.27393E+00	0.31329E+01	0.11408E+02	57.1N 356.4E
03z 21/3	1714	-0.25996E+00	0.27818E+00	0.30727E+01	0.12546E+02	64.9N 340.4E
06z 21/3	2185	-0.31920E+00	0.24714E+00	0.32171E+01	0.14119E+02	60.8N 311.6E
09z 21/3	1880	-0.58017E-01	0.18409E+00	0.33958E+01	0.14219E+02	65.7N 340.4E
12z 21/3	1770	-0.18068E+00	0.10189E+00	0.32858E+01	0.12732E+02	60.8N 311.6E

TABLE 3.2 Synop Wind (Ob-Anl)

Time & Date	Ob Count	Mean incr	rms	extreme incr	Lat/long of extreme
12z 20/3	2079	-0.13936E+01	0.12712E+02	-0.47545E+02	44.8N 44.2E
15z 20/3	1833	-0.30832E+01	0.13722E+02	-0.62375E+02	32.4N 36.3E
18z 20/3	2043	-0.59826E+01	0.13671E+02	-0.53190E+02	32.0N 36.0E
21z 20/3	1678	-0.41150E+01	0.11429E+02	-0.53068E+02	44.6N 6.5E
00z 21/3	1755	-0.40632E+01	0.11573E+02	-0.47214E+02	56.9N 258.9E
03z 21/3	1663	-0.33349E+01	0.10705E+02	-0.51389E+02	42.2N 23.6E
06z 21/3	2057	-0.18080E+01	0.11394E+02	-0.53068E+02	30.9N 353.1E
09z 21/3	1777	0.15826E+01	0.13486E+02	-0.56192E+02	52.6N 33.8E
12z 21/3	1666	-0.16767E+01	0.13042E+02	-0.67401E+02	59.4N 13.5E

TABLE 3.3 Synop RH (Ob-Anl)

Time & Date	Level	Ob Count	Mean incr	rms	extreme incr	Lat/long of extreme
12z 20/3	3	117	-0.57687E+00	0.12121E+01	0.32532E+01	44.5N 271.9E
12z 20/3	2	73	-0.48051E+00	0.13407E+01	-0.37840E+01	67.9N 44.1E
12z 20/3	1	9	-0.71097E+00	0.88464E+00	-0.16228E+01	53.3N 299.6E
00z 21/3	3	129	-0.57628E+00	0.12221E+01	0.41208E+01	40.5N 279.8E
00z 21/3	2	84	-0.60830E+00	0.16115E+01	-0.40607E+01	37.9N 284.5E
00z 21/3	1	7	0.34123E+00	0.13748E+01	-0.17923E+01	50.9N 0.3E

TABLE 3.4 Low Level Sonde Temperature (Ob-Anl)

Time & Date	Lev	Ob Count	Mean u incr	Mean v incr	rms	extreme incr	Lat/long of extreme
12z 20/3	3	105	0.2062E+00	0.1722E+00	0.2113E+01	0.4644E+01	44.1N 39.1E
12z 20/3	2	56	-0.4352E-01	-0.3186E+00	0.2581E+01	0.6435E+01	52.8N 9.9E
12z 20/3	1	8	0.6489E+00	0.4477E+00	0.3642E+01	0.6753E+01	36.7N 3.3E
00z 21/3	3	121	0.6102E-01	-0.1481E+00	0.2453E+01	0.6840E+01	54.7N 20.6E
00z 21/3	2	63	0.4970E+00	-0.5132E+00	0.2657E+01	0.6274E+01	37.9N 284.5E
00z 21/3	1	5	-0.3396E+00	0.7966E+00	0.3423E+01	0.5070E+01	67.2N 14.4E

TABLE 3.5 Low Level Sonde Winds (Ob-Anl)

Time & Date	Level	Ob Count	Mean incr	rms	extreme incr	Lat/long of extreme	
12z 20/3	3	115	0.16735E+00	0.97622E+01	-0.44166E+02	51.1N	9.3E
12z 20/3	2	70	0.73662E+00	0.98530E+01	0.31947E+02	67.9N	44.1E
12z 20/3	1	9	-0.31134E+01	0.97966E+01	-0.19931E+02	43.9N	289.8E
00z 21/3	3	131	0.25622E+01	0.96589E+01	0.30064E+02	60.8N	23.5E
00z 21/3	2	84	0.14300E+01	0.10120E+02	0.28787E+02	51.8N	36.2E
00z 21/3	1	7	0.58088E-01	0.38783E+01	0.60209E+01	50.9N	0.3E

TABLE 3.6 Low Level Sonde RH (Ob-Anl)

The following conclusions can be drawn from an assessment of these tables:

a) We could do with tighter quality control. The extreme values for surface temperature (Table 3.1) are typically >8deg and for surface wind (Table 3.2) >11m/s. It is suspected that the absence of a blacklist is largely responsible for these extreme increments

b) Despite the large extremes resulting from a few observations which are unrepresentative and should have been blacklisted, the rms values of (ob-model) are quite reasonable.

c) We seem to have small cold model temperature biases during day and smaller warm biases during night (but typically <1deg either way). This seems to be a surface feature since sondes at levels 2-3 indicate persistent warm bias.

d) Model surface winds are stronger than obs.

e) The model is too moist except at 9z with moist bias peaking at 18z (5%). Again level 2-3 sondes don't show same signal so this might also be a surface feature.

4. OBJECTIVE VERIFICATION AGAINST ANALYSES

A limited verification system was used. Forecasts from both operational and CA were verified against analyses from both suites. For the main runs (00, 12) the T+12,T+24 and T+36 forecasts were verified, For the intermediate (06,18) runs the T+6, T+18 and T+30 forecasts were verified. The parameters verified were pressure at mean sea-level, 500hPa height, temperatures at 850hPa and 250hPa, and wind speed and vector wind error at 250hPa.The mean results for the period 15/03/95 to 10/04/95 (26 cases) , which included the land synops, will be discussed.

Figure 4.1 shows the mean results for rms errors of surface pressure from the four forecast runs. Each graph shows the errors at 3 forecast periods (12,24,36 or 6,18,30) for :

the operational forecasts compared to the operational analyses(op/op), the operational forecasts compared to the CA analyses (op/ca), the CA forecasts compared to the operational analyses (ca/op), and the CA forecasts compared to the CA analyses (ca/op).

The general pattern evident here (and for the other parameters see **Figs 4.2-4.6**) is for the forecasts to verify better against analyses from their own suites. The cross verifications (op/ca and ca/op) shows larger errors, particularly for the intermediate runs. The differences are most marked at short periods (T+12 or T+6).

Figures 4.7-4.9 show the mean errors over the forecast periods (12,24,36 or 6,18,30) for each run. Surface pressure errors from the main runs are similar for the operational and CA, when verified against their own analyses. For the intermediate runs the operational (op/op) errors are the smallest (**Fig 4.7**) . For 500hPa (**Figs 4.2,4.7**), the operational (op/op) and CA (ca/ca) errors are equal for the 06,18 runs but for the main runs the CA (ca/ca) errors are smallest.

Temperature errors at 250hPa (**Figs 4.4, 4.8**) are least for the continuous assimilation (ca/ca), but at 850hPa the operational errors (op/op) are least for all runs (**Figs 4.3, 4.8**).

Wind speed and vector wind errors are smallest for CA (ca/ca) for both main and intermediate runs (**Figs 4.5,4.6 and 4.8**).

The overall impression from these verification figures is that the CA forecasts are better for upper level winds and temperatures, about equal to operational for 500hPa and surface pressure, and worse for 850hPa temperatures. The scores are therefore slightly in favour of the continuous assimilation.

5. SUBJECTIVE ASSESSMENT OF RAINFALL FORECASTS.

5.1 Rainfall assessment.

Rainfall forecasts from the continuous assimilation trial and the operational suite were compared and assessed over the British Isles, Ireland, Northern France , Belgium and Holland using radar, observations and satellite imagery. The trial forecasts were assessed as **A, B or C** according to the following code:

A = trial rainfall forecast more accurate than operational
B = trial and operational rainfall forecasts similar
C = trial rainfall forecast less accurate than operational.

The main run forecasts from DT00Z and DT12Z were assessed at T+06, T+12, T+24 and T+36. The intermediate run forecasts from DT06Z and DT18Z were assessed at T+06, T+18 and T+30 in order to make it easier to check for consistency between intermediate and main forecast runs. Overall , differences in the mean sea level pressure pattern were small and no evolution changes were noted. There were differences of 2-4hPa between trial and

operational depressions, but the trial depressions were not always deeper. However, overall, trial troughs tended to be slightly sharper with rainbands more clearly defined. Over the U.K., there were several differences in forecast precipitation due to small timing differences and changes in shower distribution. The results from the assessment are summarised in Table 5.1 below. As Table 5.1 shows, the assessment was generally neutral, but with a slight overall advantage to the trial forecasts.

PERIOD	20/2 - 15/3			15/3 - 10/4		
DT00	**A**	**B**	**C**	**A**	**B**	**C**
T+06	2	18	2	2	24	0
T+12	2	19	3	2	21	3
T+24	4	15	3	3	19	4
T+36	6	9	7	3	23	0
total	14	61	15	10	87	7
DT06	**A**	**B**	**C**	**A**	**B**	**C**
T+06	3	17	2	1	24	2
T+18	4	16	2	4	21	1
T+30	6	11	5	2	24	2
total	13	44	9	7	69	5
DT12	**A**	**B**	**C**	**A**	**B**	**C**
T+06	1	19	1	2	22	1
T+12	2	19	0	0	25	1
T+24	5	12	4	2	21	3
T+36	3	16	2	4	22	0
total	11	66	7	8	90	5
DT18	**A**	**B**	**C**	**A**	**B**	**C**
T+06	2	16	3	2	24	1
T+18	6	12	4	2	21	4
T+30	2	15	5	4	19	2
total	10	43	12	8	64	7
overall	48	214	43	33	310	24

TABLE 5.1 SUBJECTIVE ASSESSMENT OF RAINFALL FORECASTS

The impact on rainfall forecasts is illustrated by the following examples, which show some of the biggest differences noticed between trial and operational forecasts.

The code for the symbols seen in the forecast charts refer to the following precipitation rates:

	0.03	**0.1**	**0.5**	**4.0**	**mm/hr at verifying time**
SNOW	x	x	*	*	
CONVECTIVE	v	v	V	V	
DYNAMIC	.	o	o	o	

5.2 Case Studies - February 20th to March 15th 1995

(i) Wave Depression - T+06 forecast verifying at 00Z 25/02/95

At 00Z 25/02/95, a small wave depression was centred over Cornwall and moving quickly eastward. The radar image for this time, **FIGURE 5.1a**, shows an area of rain over Wales and the West Midlands to the north of the wave, with a band of rain over Southwest England associated with the warm front. The light showers predicted at T+06 by the operational model, **FIGURE 5.1b**, did not really cover the extent and intensity of the rain over Wales and the Midlands, and the trial forecast, **FIGURE 5.1c**, was better in this case.

(ii) Cold Front - T+06 forecast verifying at 06Z 11/03/95

The radar image for 06Z 11th March, **FIGURE 5.2a**, shows a narrow band of rain associated with a cold front lying from Manchester to Cardiff to Brest. There were significant differences in the rainfall predicted by the trial and operational forecasts at T+06. The operational forecast, **FIGURE 5.2b**, was slightly fast, predicting the cold front to be over the Midlands rather than Wales. Although the position of the cold front was more accurately predicted by the trial forecast, **FIGURE 5.2c**, the showers predicted over Eastern England were incorrect.

(iii) Unstable westerly airstream - T+18 forecast verifying at 12Z 21/02/95.

A cold front cleared Southeast England by 06Z, allowing a cold and unstable westerly airstream to become established over the U.K.. By 12z, the radar image, **FIGURE 5.3a**, shows widespread showers particularly over Southern Scotland and also further south over the Midlands and Southern England. Some of these showers were heavy with hail and isolated thunderstorms with snow over hills in the north. The distribution of showers over the Midlands and Southern England were better predicted by the trial forecast, **FIGURE 5.3c**.

(iv) Atlantic Depression - T+24 forecast verifying at 18Z 06/03/95.

A comparison between the trial and operational T+24 forecasts verifying at 18z 6th March was interesting because it showed a slight difference in the forecast evolution of an Atlantic depression. The trial forecast, **FIGURE 5.4b**, showed extra detail with a strong northerly flow to the west of the depression. No observations could be found to validate the true pattern of the depression.

(v) Depression over Scotland - T+36 forecast verifying at 06Z 08/03/95.

The analysis for 06Z 8th March, **FIGURE 5.5b**, shows a depression centred over Western Scotland and a band of rain associated with an occlusion in the North Sea. The radar image for this time, **FIGURE 5.5a**, shows a little rain in the southeast associated with the occlusion and the distribution of the widespread showers in the west. The operational forecast, **FIGURE 5.6a**, predicted a band of snow and rain in the east which was poorly timed and the trial forecast, **FIGURE 5.6b**,was better.

(vi) Spurious wave - T+36 forecast verifying at 12Z 14/03/95.

At 12Z 14th March, a cold front Northeast England to Wales was moving slowly southeast. The rainfall associated with the cold front was light, but more widespread than indicated by the radar image for 12z, **FIGURE 5.7a**. The rainfall is better indicated by the radar image for 14Z shown in **FIGURE 5.7b**. The operational forecast for T+36,**FIGURE 5.8a**, was completely wrong, predicting widespread rain over much of Northern England, Wales and ireland associated with a wave on the front. The trial forecast, **FIGURE 5.8b**, was clearly better in spite of a timing error of about three hours.

5.3 Case Studies - March 16th to April 12th 1995

The extra observations of land surface temperature, winds and relative humidity included during this period did not seem to have much impact on early precipitation forecasts and we probably need to include cloud and rainfall analysis to achieve a noticeable impact. The examples described below are taken from the period March 25th to April 1st, since the weather during April was dominated by high pressure.

(vii)Weak Cold Front - T+06 forecast verifying at 06Z 25/03/95

The radar image for 06Z 25th March, **FIGURE 5.9a**, shows some narrow bands of light rain associated with a weak cold front lying from Dublin to Southeast England. Again, there were slight differences in the rainfall predicted by the two versions. The trial model, **FIGURE 5.9c**, predicted a more definite band of light rain on the cold front, but amounts were too large over Wales.

(viii) Weak Warm Front - T+12 forecast verifying at 06Z 01/04/95

The morning of April 1st was mild in most places with some light rain and drizzle mostly over coasts and hills in the northwest, as indicated by the radar image, **FIGURE 5.10a**. Both forecasts predicted too much rain associated with a weak warm front which crossed Scotland overnight. However, rainfall errors were worse in the operational T+12 forecast, **FIGURE 5.10b**, which predicted rain as far south as East Anglia and Southeast England.

(ix) Succession of fronts approaching U.K. - T+24 forecast verifying at 12Z 30/03/95.

A mild southwesterly airstream brought a succession of fronts from the Atlantic across Northern Ireland, Scotland and Northern England. At 1230Z 30th March, the radar image, **FIGURE 5.11a**, shows a band of quite heavy rainfall over Northeast England associated with a warm front. The operational forecast, **FIGURE 5.11b**, was slow with the timing of this rain, but the trial forecast, **FIGURE 5.11c**, failed to predict any rain at all over Northeast England.

There was a marked difference between the forecasts at 10-15W, with the trial forecast predicting a band of dynamic rainfall, suggesting an active front or trough. The band was weaker and mainly showery in the operational forecast. The meteosat infra-red image, **FIGURE 5.12**, showed a band of upper cloud in this region. In the Bracknell analysis, this was analysed as a trough with the cold front still well to the west. The trough was a weak feature, producing only light rain, hence the trial forecast was overdone.

(x) Active Cold Front - T+24 forecast verifying at 00Z 27/03/95.

The radar image for 00Z 27th March, **FIGURE 5.13a**, shows a band of heavy rainfall associated with a cold front from Humberside to North Wales, with rates 4-8mm/hr. To the north of this front, the air was much colder and clearer with occasional snow showers. The trial forecast, **FIGURE 5.13c**, was assessed as 'C' due to over-prediction of rain in the south. This was a little unlucky, since there were observations of intermittent light rain and drizzle in the milder air south of the front which are not indicated on the radar image. However, the operational forecast, **FIGURE 5.13b**, located the area of heaviest rain on the front better.

(xi) Depression bringing snow to the east - T+30 forecast verifying at 12Z 28/03/95.

The radar image for 12Z 28th March, **FIGURE 5.14a**, shows a band of precipitation, rates 0.5-1.0 mm/hr over Eastern England, with a further large area of rain over Brest and the Channel. The precipitation fell as snow in the east, as shown by the observations in **FIGURE 5.14c**. The heaviest snow occurred over Northern England close to the depression centred near Liverpool, **FIGURE 5.14b**. Both forecasts gave a good prediction at T+30 both of the centre of the depression and of snowfall in the east. The trial forecast, **FIGURE 5.15b**, was more accurate with the depth and position of the depressions but there were the usual pluses and minuses associated with the precipitation forecasts: both over-predicted rain in the west, light snowfall over Northeast England and Southern Scotland (missed by the radar) was better in the trial forecast, snow over Southeast England better in the operational forecast.

6 CONCLUSIONS

The results of this study show that a continuous assimilation cycle for the LAM is marginally better than the intermittent operational cycle. This conclusion is supported by both the majority of the objective verification parameters and the subjective assessment of precipitation forecasts. Little impact is evident from the inclusion of synop data over land, although the operational verification against stations should show smaller analysis errors for surface variables. It is recommended that the synop land data be included for consistency with the mesoscale model configuration, but only after a suitable blacklist has been put in place and OPD studies have demonstrated that the (ob-background) for those observations being presented to the assimilation are acceptably small in a variety of seasonsal situations.

The study would have been improved by the inclusion of more objective verification, such as verification against station observations, including precipitation , but this was not practical at the time. Despite this drawback there is little to suggest that limited area model forecasts would be degraded and would generally be improved. The change to a continuous cycle makes the system logically consistent as explained in the introduction and prepares for tests of including satellite derived cloud and moisture data through an extended MOPS system.

APPENDIX

A suite of jobs has been set up to enable a continuous assimilation (CA) to be run for the LAM model. No observation processing was carried out. The operational observation files and boundary datasets were used. The main difference between the CA and operational suite was the removal of the interpolation from the global main analyses to get the corresponding LAM start analyses. In the CA suite the LAM analyses were continually used in the assimilation cycles.

(a). UM Experiment for the CA suite.

The UI experiment SC2A (UM Version 3.3, MS15.DRSC2AB/J.VN3#03) contains five jobs for the CA suite as listed below:

L : 4 cycles from 12Z to 00Z plus a 48 hour f/c.
M : 4 cycles from 00Z to 12Z plus a 48 hour f/c.
N : Intermediate run for 18Z plus a 48 hour f/c.
O : Intermediate run for 06Z plus a 48 hour f/c.
P : Reconfiguration only job. For 12Z only.

From March 9th, the CA used UI experiment SC4H (UM Version 3.4, MS15.DRSC4HB/J.VN3#04)

(b). Running the CA suite.

The daily 24 hour period for running the jobs starts at 15Z daily. Each run of the CA suite starts from 12Z (QL12) analysis for the previous day and runs 8 cycles to 12Z the next day. (ie. at 15z on 21st, the CA will run from 12Z 20th to 12z 21st). The intermediate assimilation cycles are also run to 06Z and 18Z. A 48 hour forecast is run four times a day from 00Z, 12Z, 18Z and 06Z. (UM Jobs L, M, N and O).

Jobs are run in the following order :-

Job A. At 15Z copy all operational LAM ACOBS files, Boundary Condition files into CA suite. There are two other jobs involved to copy the intermediate ACOBS files (QL06 and QL18) at earlier times before they are overwritten in the update (QV06 and QV18) runs. They are stored until 15Z when they are copied into the CA suite. The operational QL12 analysis is also copied in case a restart is required the next day.

Job P submitted by Job A.
Reconfigure the 12Z Analysis.
Job L submitted by Job P.
Four assimilation cycles QL15, QV18, QL21 and QL00 then a 48 hour f/c.
Job N submitted by Job P.
Two assimilation cycles QL15 and QL18 then a 48 hour f/c.
Job M submitted by Job L.
Four assimilation cycles QL03, QV06, QL09 and QL12 then a 48 hour f/c.
Job O Submitted by Job L.
Two assimilation cycles QL03 and QL06 then a 48 hour f/c.<p>

Back to Job A.

Note that the cycles QL15 and QL03 are repeated twice. The main reason for this to enable the jobs be submitted earlier within the 24 hour limit to complete the assimilations.

(c). Reconfiguration.

Even though the the LAM analyses are no longer reconfigured from the global analyses, a reconfiguration step is still needed to update a number of ancillary fields as follows :-

Ozone.

A new ozone ancillary file has been created for the CA suite. This file contains 9 levels of data corresponding to model levels 11-19 and the data is for the full grid - not zonal data as in the operational suite. There is no time interpolation at present for ozone data, so effectively the reconfiguration copies the data for the month corresponding to 12Z. Note that there are 6 ozone levels (model levels 14_19) in the operational suite.

Soil Moisture.

This is updated from the ancillary file qrclim.smow. Time interpolation is used with this data.

SST Field.

This is updated from the ancillary file qwla.daily.sst which is updated in the LAM SST Analysis set up for this experiment. See details below on the LAM SST Analysis.

ICE fields.

The Ice fraction and Ice depth fields are updated from the ancillary file qwla.daily.ice. See below for details on the LAM ICE Analysis.

(d). Restart Option.

The suite can be restarted any day at 15Z by setting a variable RESTART to true in the HDS dataset MS15.DR.RESTART.This must be done before 1500Z to put a restart into effect for the 24 hour run starting from 1500Z that day. (A restart at 15Z corresponds to a restart at 12Z the previous day in the CA suite). This dataset is read in job P and if RESTART=true then the operational QL12 analysis replaces CA QL12 analysis. After restarting, RESTART is reset to false to prevent any accidental restarts in future runs.

(e).LAM SST Analysis

A new suite of jobs has been set up to run this analysis daily as in the global suite. The observations on the LAM grid in the global SST ACOBS file are used for the analysis. The global SST analysis runs at approximately 1215Z daily and the LAM SST analysis is set up to run at 17Z daily and the analysis is used in the reconfiguration at 15Z the next day. The SST field is put in the HDS dataset - MS15.DRLINK.LASST - daily enabling one to plot the SST field. This has been running daily since 07/02/95.

(f).LAM ICE Analysis

In the operational suite a global Ice Analysis is run weekly in the QG06 runs on Wednesdays and reconfigured in the global model in the QG12 run. The ice fields are then interpolated to the LAM grid at the start of the QL15 run on Wednesdays. For the CA suite, a job is run once weekly on Thursday before 15Z to copy two fields - Ice Fraction and Ice Depth - from the operational QL15 analysis into the ancillary file qwla.daily.ice.
Note that this field is used for seven days until updated the following week. The fields are put into the HDS dataset - MS15.DRLINK.LAICE - as for SST.

(g). Chart plotting/Verification.

At the end of each 48 hour forecast, jobs are submitted to transfer the PP files to the HDS for plotting and to the HP for verification.

(h).Changes made during the CA trial.

CA suite started February 20th (12z 19/02 analysis).
March 5th : CA restarted at 12z 4/3/95 after (system) problems on 3rd.
March 9th : CA moved up from UM 3.3 to 3.4 at 12z 8th. UM Experiment changed from SC2A to SC4H. Reconfiguration from 3.3 to 3.4 done in SC4H/Q which includes new land sea mask and all ancillary files.
March 16th : Land Synops included in assimilation from 12z 15th March.
Surface Temp, Winds and RH over land. AC Types 204/304/404.
Assimilation Namelist amended as follows :-

RADINF=2.25 for 204/304/404
CSCALE_START=150/240/150 km for 204/304/404
CSCALE_OBTIME=120/150/120 km for 204/304/404
CSCALE_END=120/150/120 km for 204/304/404
CSCALE_VERT(1,1)=12.0 for Surface Temps/RH (204/404)
N_ANAL_LEVS=3/5/3 for 204/304/404

March 17th : Assimilation diagnostics switched on
March 22nd : Assimilation diagnostics switched off.
April 13th : Continuous Assimilation switched off (Ended 12z 12th in suite).

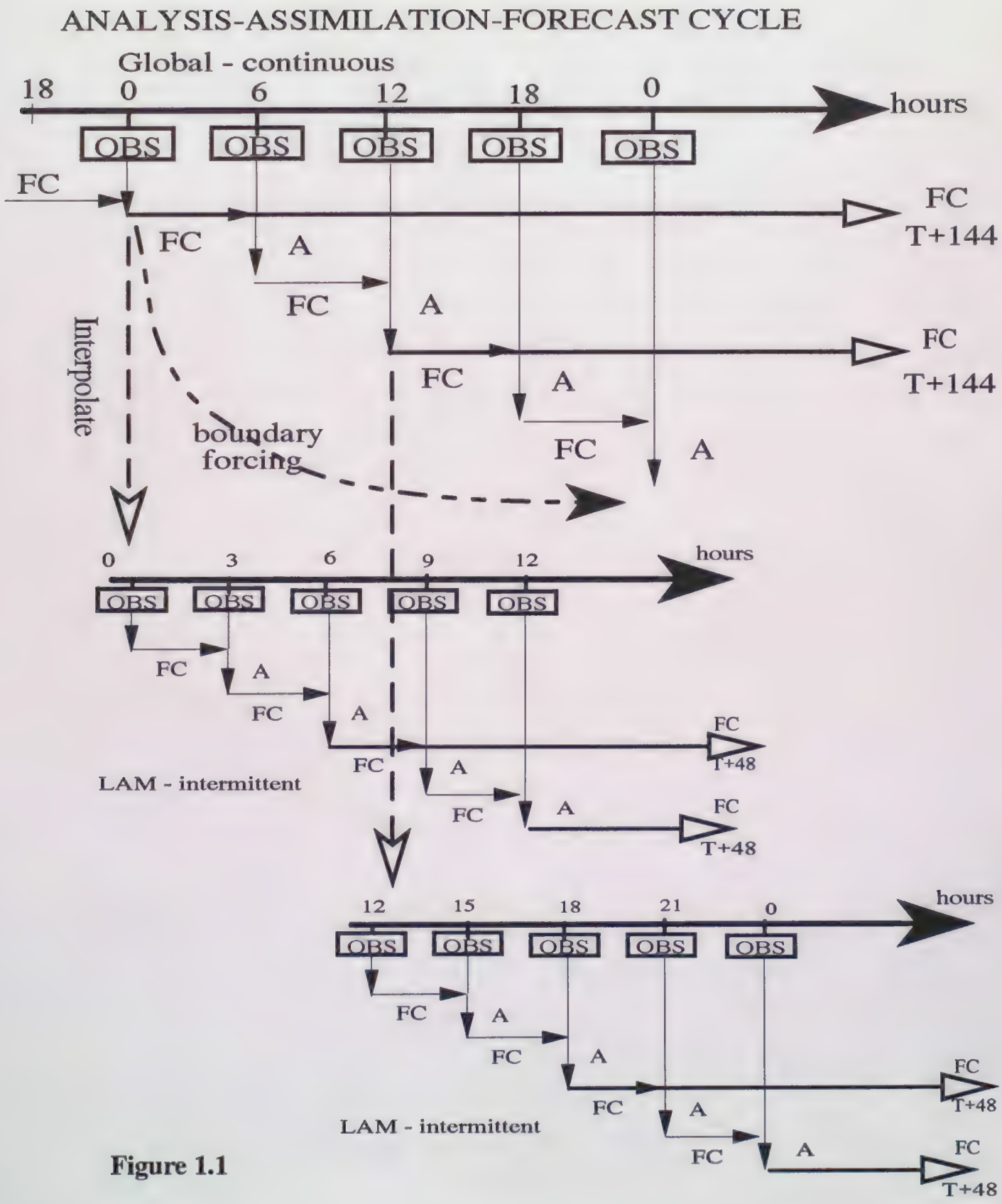
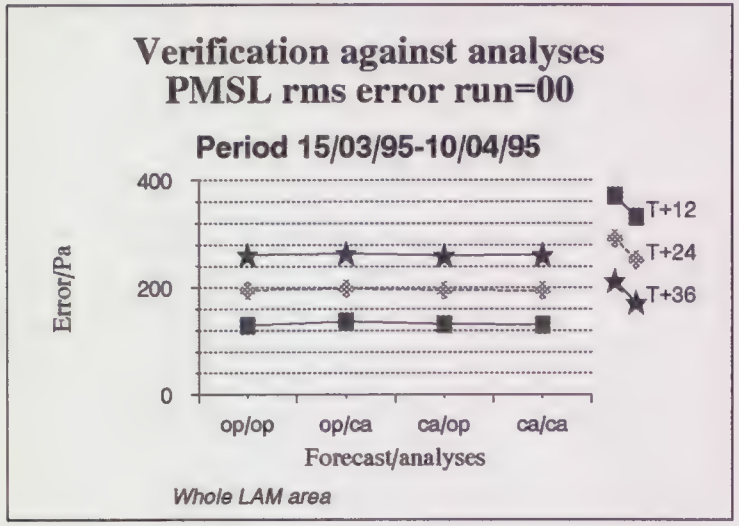
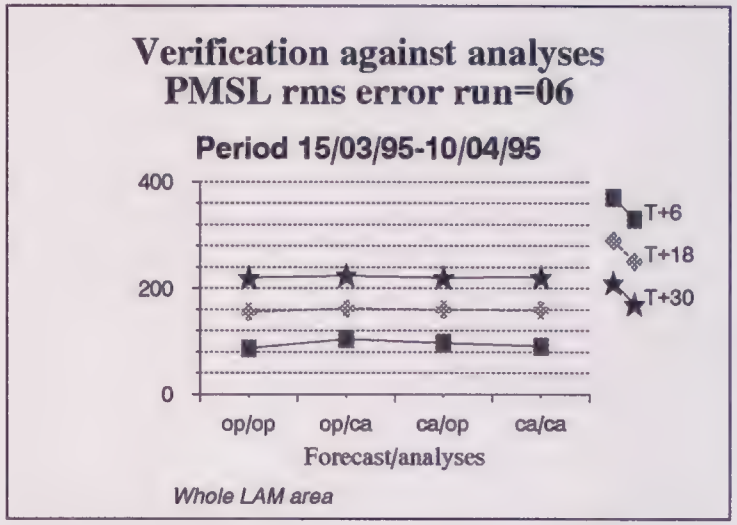
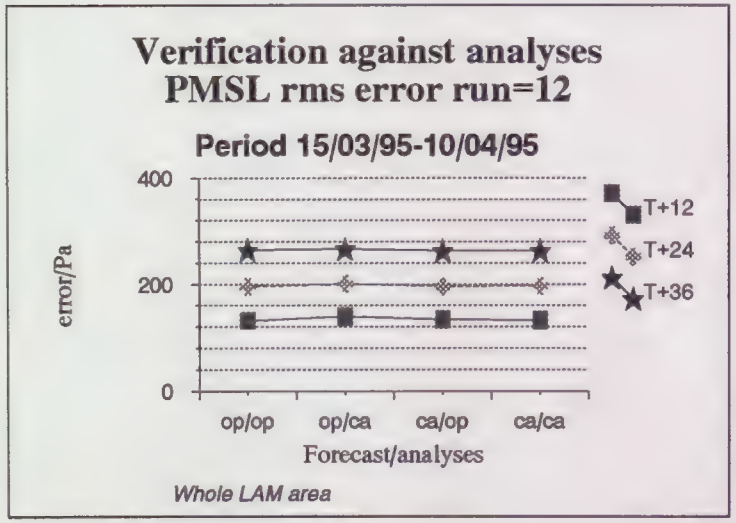

ANALYSIS-ASSIMILATION-FORECAST CYCLE
Global - continuous
18
0
6
12
18
0
hours
OBS
OBS
OBS
OBS
OBS
FC
FC
FC
T+144
A
FC
A
FC
FC
T+144
A
FC
A
Interpolate
boundary
forcing
0
3
6
9
12
hours
OBS
OBS
OBS
OBS
OBS
FC
A
FC
A
FC
FC
T+48
A
FC
A
FC
T+48
LAM - intermittent
12
15
18
21
0
hours
OBS
OBS
OBS
OBS
OBS
FC
A
FC
A
FC
FC
T+48
A
FC
A
FC
T+48
LAM - intermittent

Figure 1.1


Verification against analyses
PMSL rms error run=00
Period 15/03/95-10/04/95
Error/Pa
400
200
0
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
T+12
T+24
T+36
Whole LAM area


Verification against analyses
PMSL rms error run=06
Period 15/03/95-10/04/95
400
200
0
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
T+6
T+18
T+30
Whole LAM area


Verification against analyses
PMSL rms error run=12
Period 15/03/95-10/04/95
error/Pa
400
200
0
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
T+12
T+24
T+36
Whole LAM area

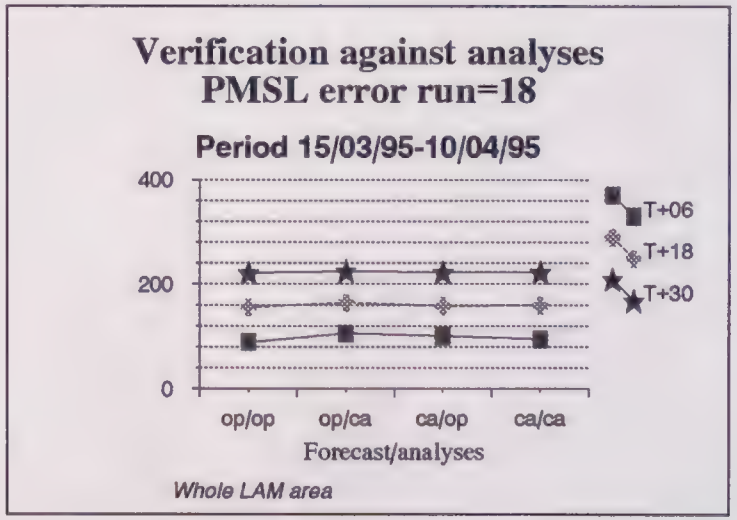
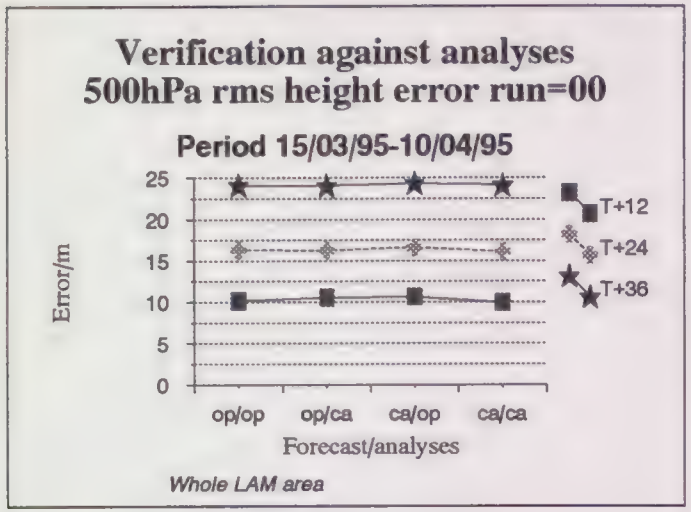
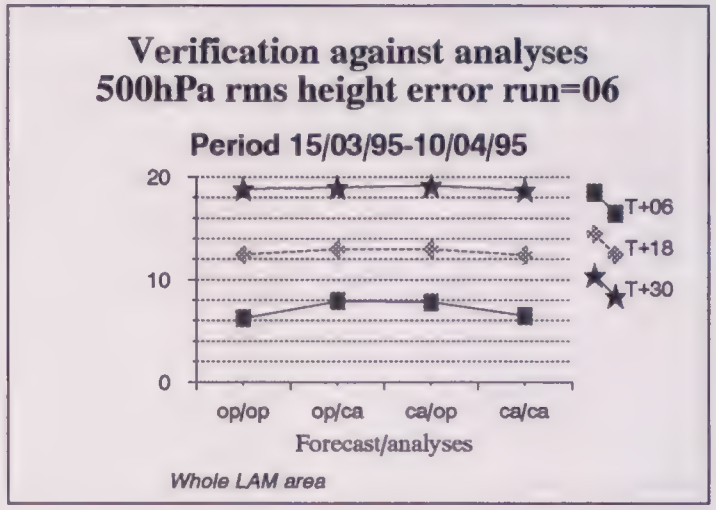
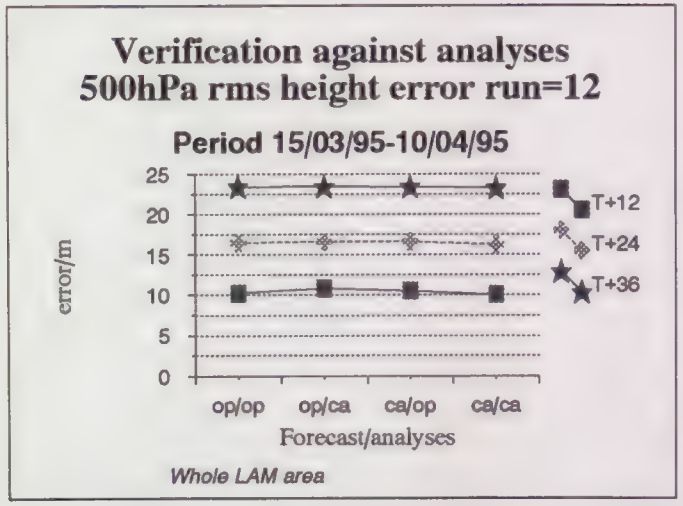

Verification against analyses
PMSL error run=18
Period 15/03/95-10/04/95
400
200
0
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
T+06
T+18
T+30
Whole LAM area

Figure 4.1


Verification against analyses
500hPa rms height error run=00
Period 15/03/95-10/04/95
Error/m
25
20
15
10
5
0
T+12
T+24
T+36
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
Whole LAM area


Verification against analyses
500hPa rms height error run=06
Period 15/03/95-10/04/95
20
10
0
T+06
T+18
T+30
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
Whole LAM area


Verification against analyses
500hPa rms height error run=12
Period 15/03/95-10/04/95
error/m
25
20
15
10
5
0
T+12
T+24
T+36
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
Whole LAM area

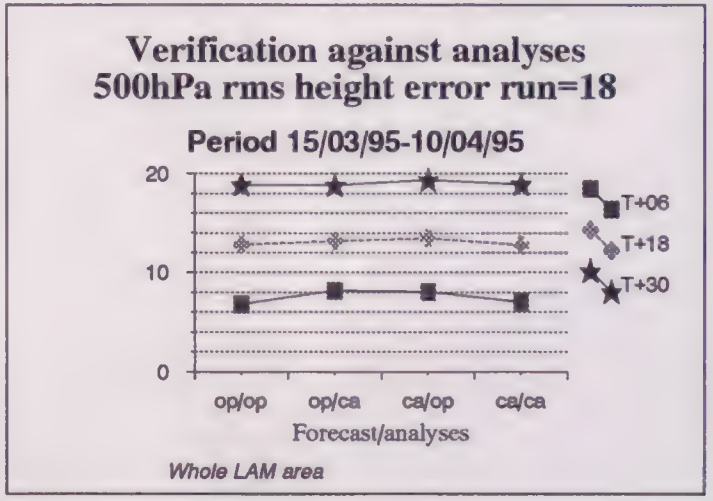
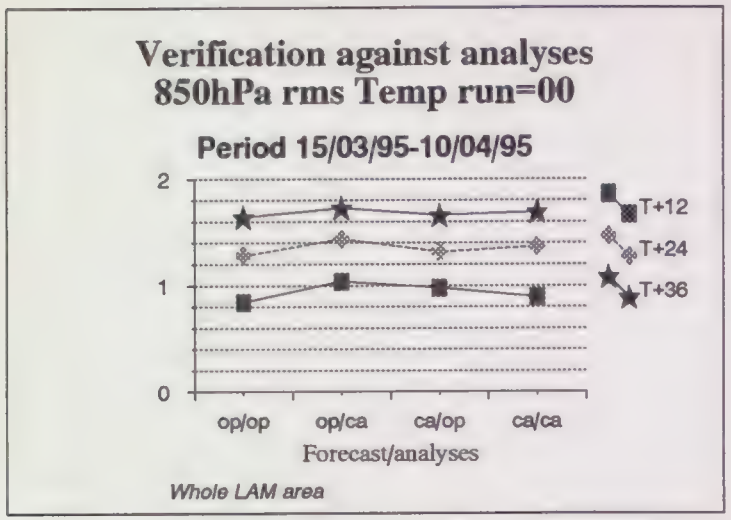
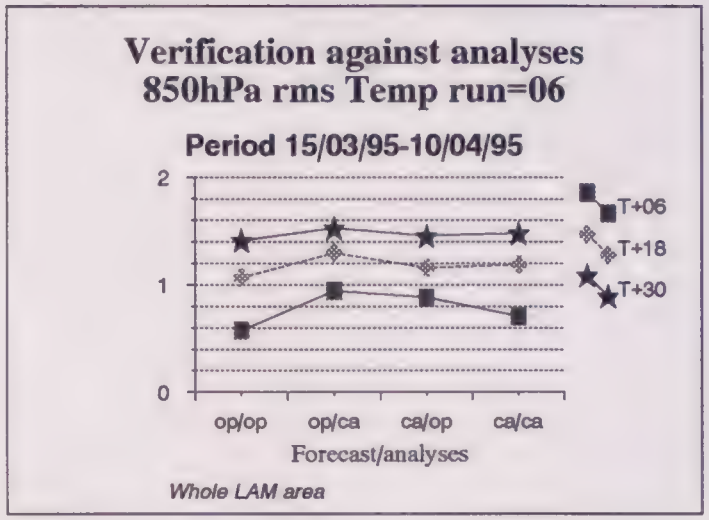
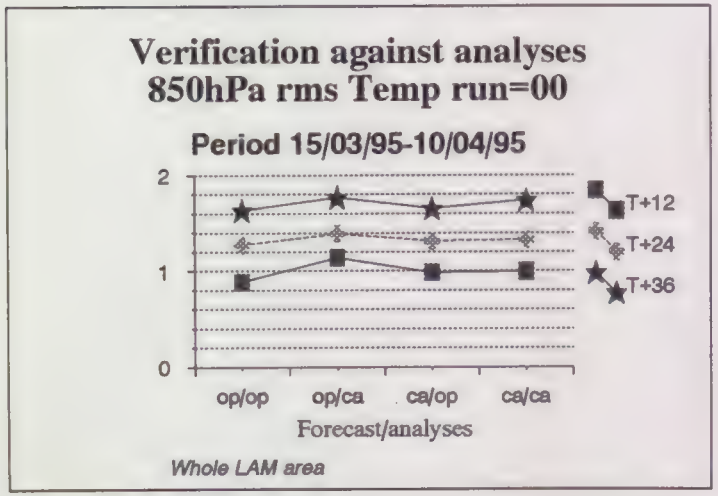

Verification against analyses
500hPa rms height error run=18
Period 15/03/95-10/04/95
20
10
0
T+06
T+18
T+30
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
Whole LAM area

Figure 4.2


Verification against analyses
850hPa rms Temp run=00
Period 15/03/95-10/04/95
2
1
0
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
T+12
T+24
T+36
Whole LAM area


Verification against analyses
850hPa rms Temp run=06
Period 15/03/95-10/04/95
2
1
0
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
T+06
T+18
T+30
Whole LAM area


Verification against analyses
850hPa rms Temp run=00
Period 15/03/95-10/04/95
2
1
0
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
T+12
T+24
T+36
Whole LAM area

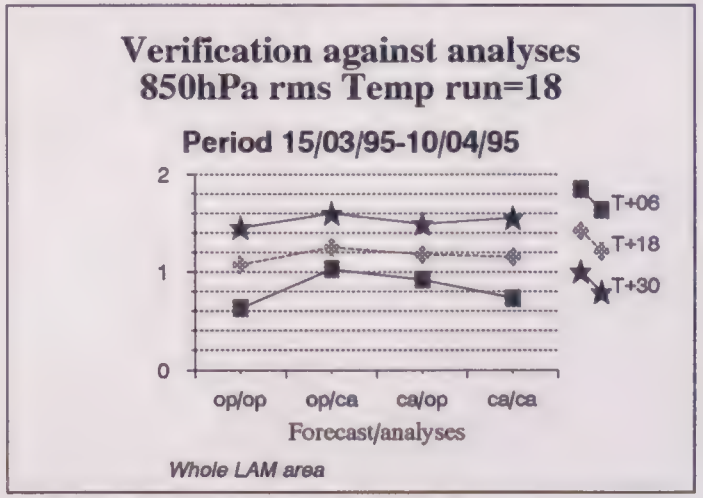
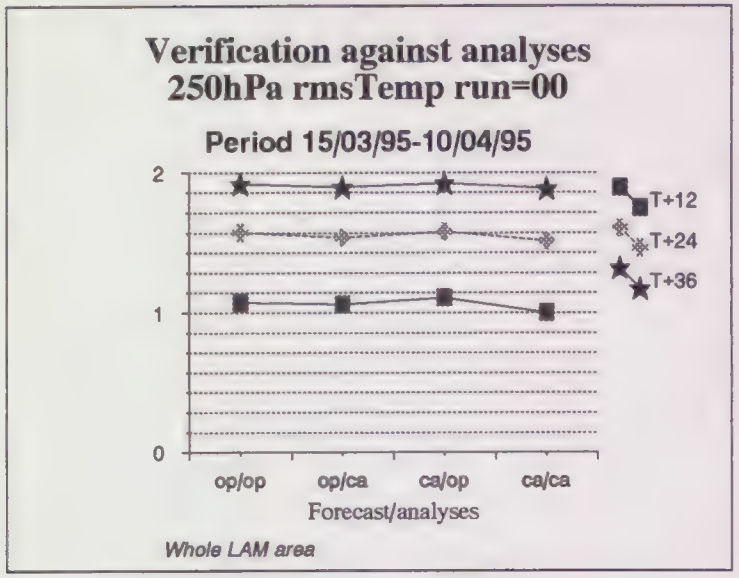
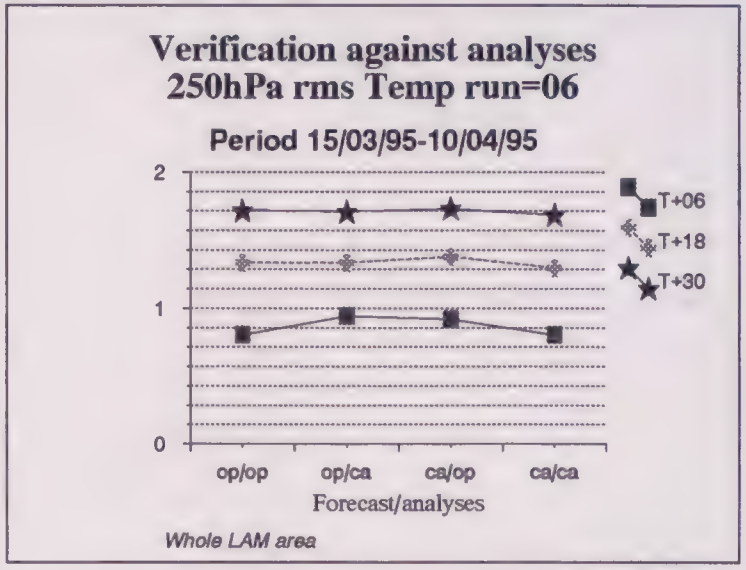
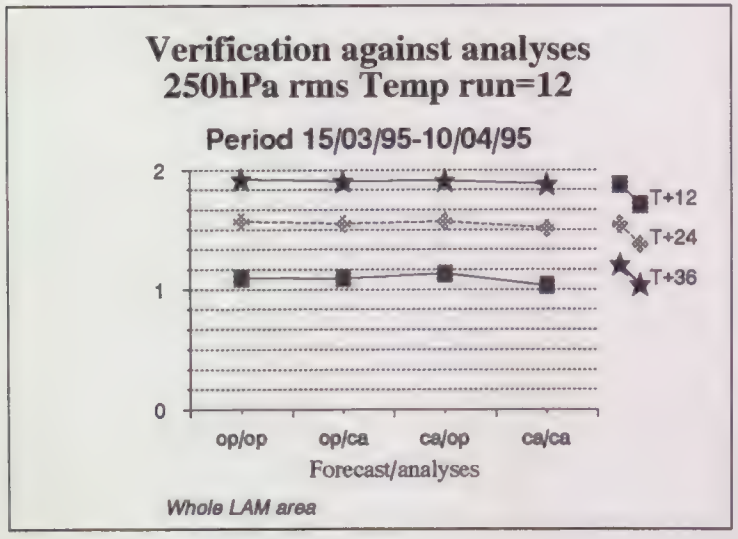

Verification against analyses
850hPa rms Temp run=18
Period 15/03/95-10/04/95
2
1
0
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
T+06
T+18
T+30
Whole LAM area

Figure 4.3


Verification against analyses
250hPa rmsTemp run=00
Period 15/03/95-10/04/95
2
1
0
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
T+12
T+24
T+36
Whole LAM area


Verification against analyses
250hPa rms Temp run=06
Period 15/03/95-10/04/95
2
1
0
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
T+06
T+18
T+30
Whole LAM area


Verification against analyses
250hPa rms Temp run=12
Period 15/03/95-10/04/95
2
1
0
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
T+12
T+24
T+36
Whole LAM area

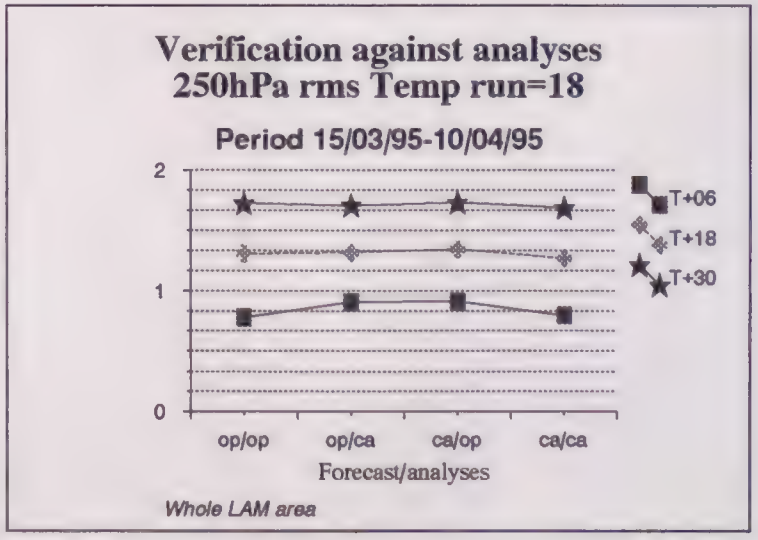
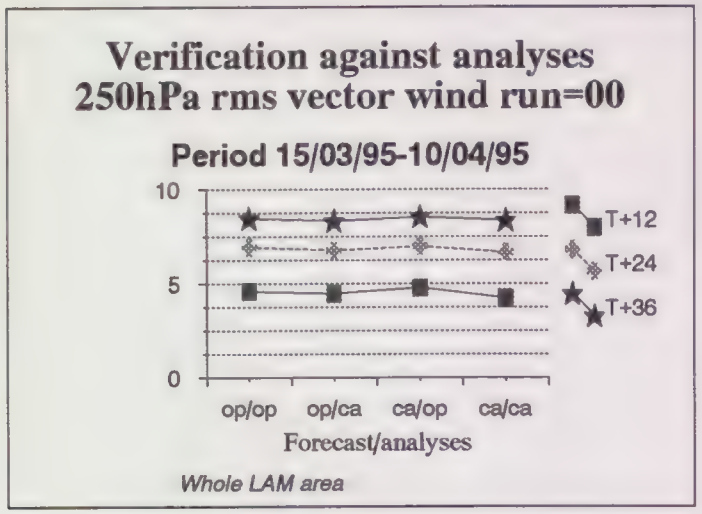
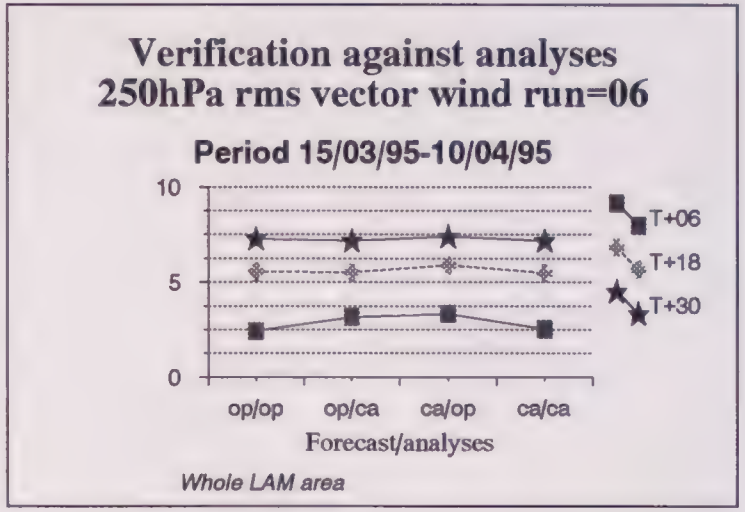
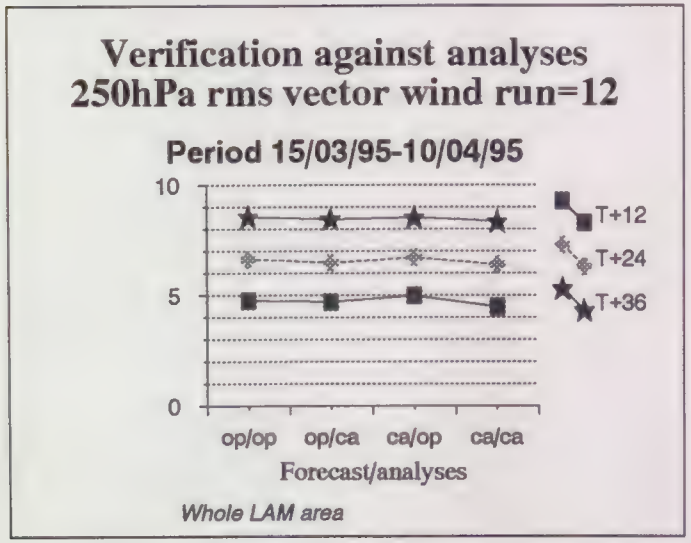

Verification against analyses
250hPa rms Temp run=18
Period 15/03/95-10/04/95
2
1
0
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
T+06
T+18
T+30
Whole LAM area

Figure 4.4


Verification against analyses
250hPa rms vector wind run=00
Period 15/03/95-10/04/95
10
5
0
T+12
T+24
T+36
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
Whole LAM area


Verification against analyses
250hPa rms vector wind run=06
Period 15/03/95-10/04/95
10
5
0
T+06
T+18
T+30
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
Whole LAM area


Verification against analyses
250hPa rms vector wind run=12
Period 15/03/95-10/04/95
10
5
0
T+12
T+24
T+36
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
Whole LAM area

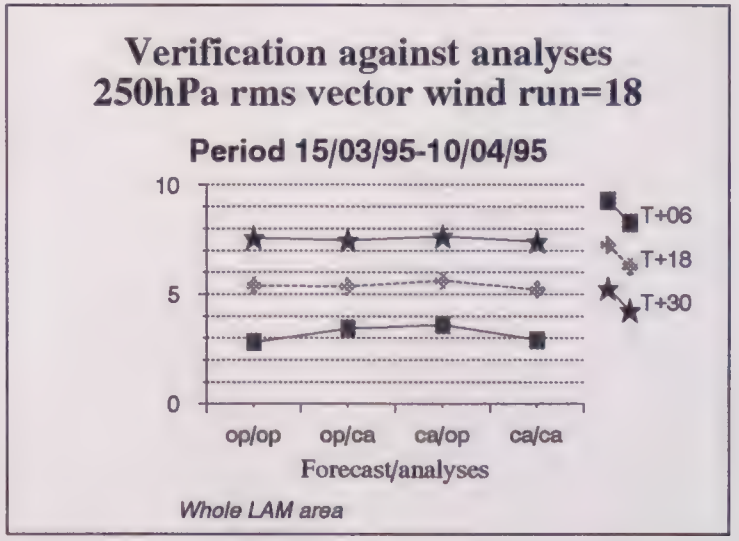
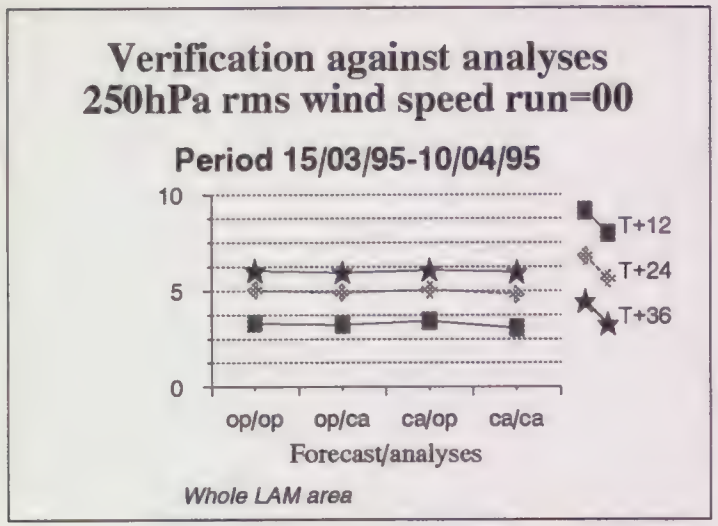
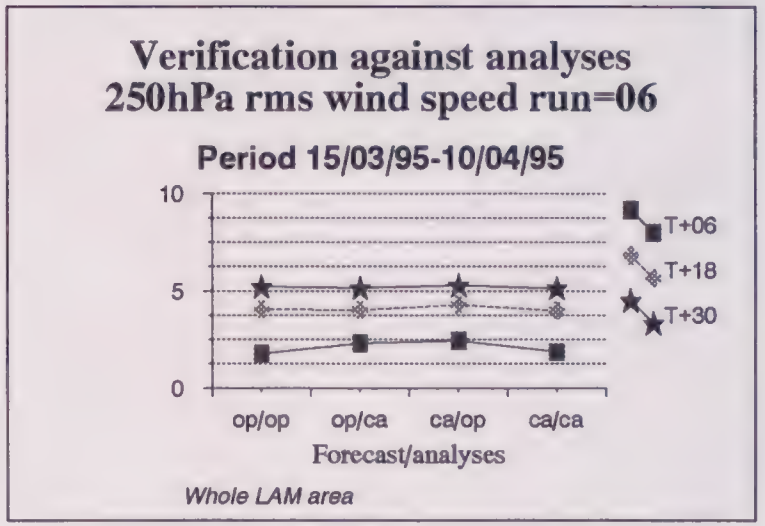
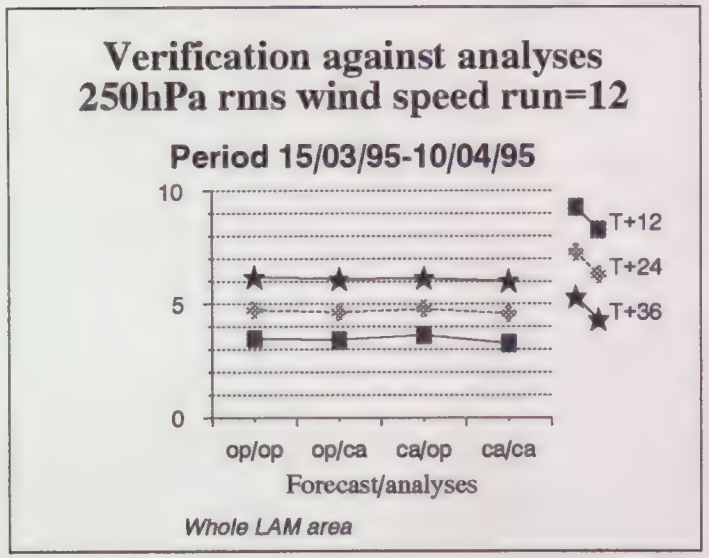

Verification against analyses
250hPa rms vector wind run=18
Period 15/03/95-10/04/95
10
5
0
T+06
T+18
T+30
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
Whole LAM area

Figure 4.5


Verification against analyses
250hPa rms wind speed run=00
Period 15/03/95-10/04/95
10
5
0
T+12
T+24
T+36
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
Whole LAM area


Verification against analyses
250hPa rms wind speed run=06
Period 15/03/95-10/04/95
10
5
0
T+06
T+18
T+30
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
Whole LAM area


Verification against analyses
250hPa rms wind speed run=12
Period 15/03/95-10/04/95
10
5
0
T+12
T+24
T+36
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
Whole LAM area

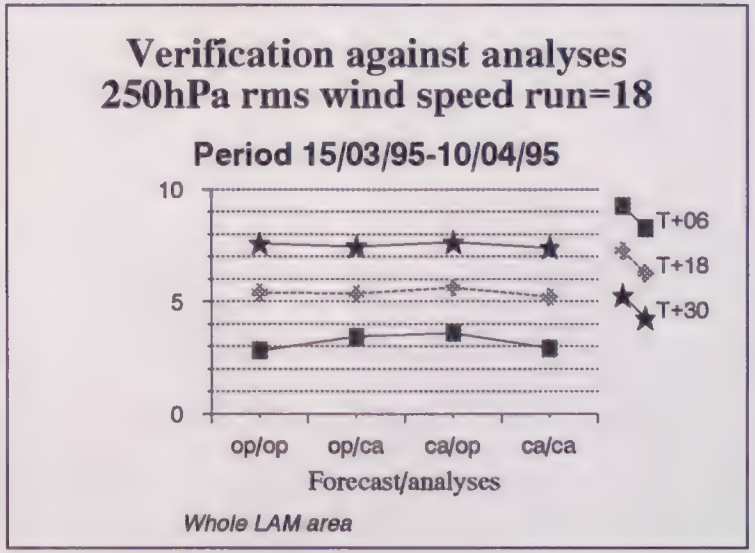
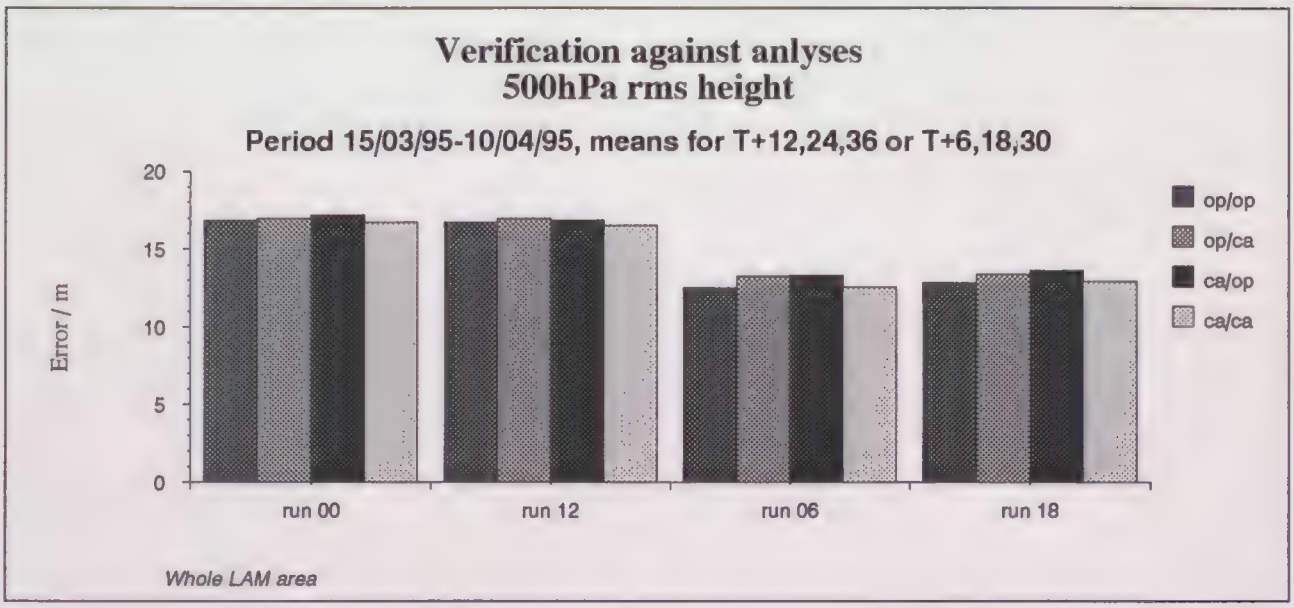

Verification against analyses
250hPa rms wind speed run=18
Period 15/03/95-10/04/95
10
5
0
T+06
T+18
T+30
op/op
op/ca
ca/op
ca/ca
Forecast/analyses
Whole LAM area

Figure 4.6


Verification against anlyses
500hPa rms height
Period 15/03/95-10/04/95, means for T+12,24,36 or T+6,18,30
Error / m
20
15
10
5
0
run 00
run 12
run 06
run 18
op/op
op/ca
ca/op
ca/ca
Whole LAM area

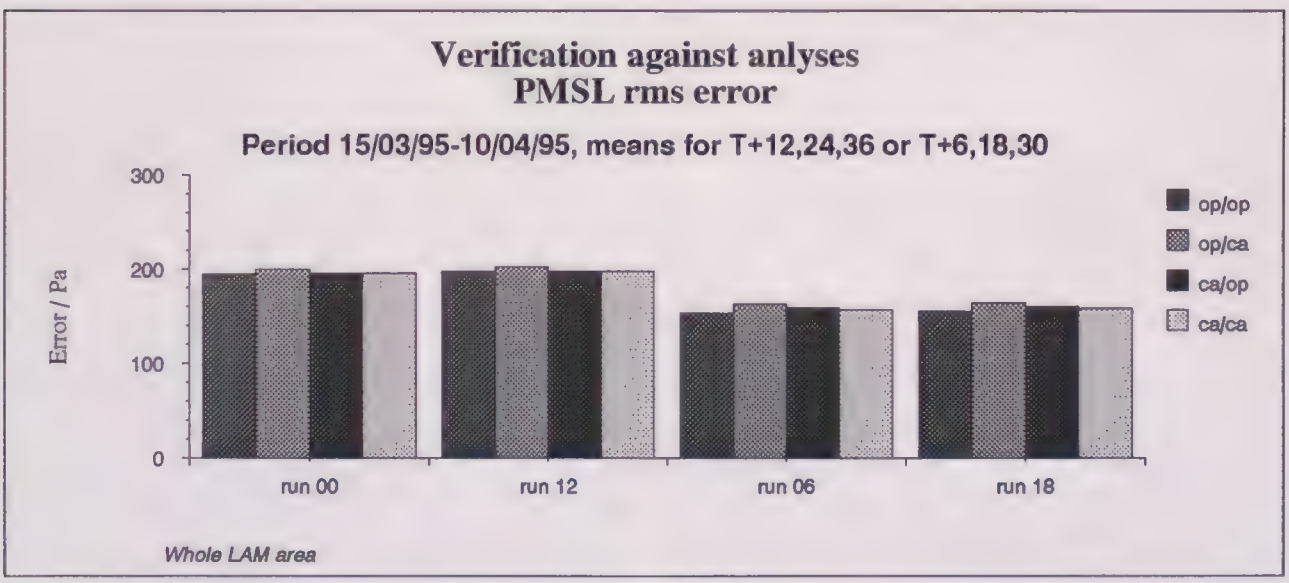
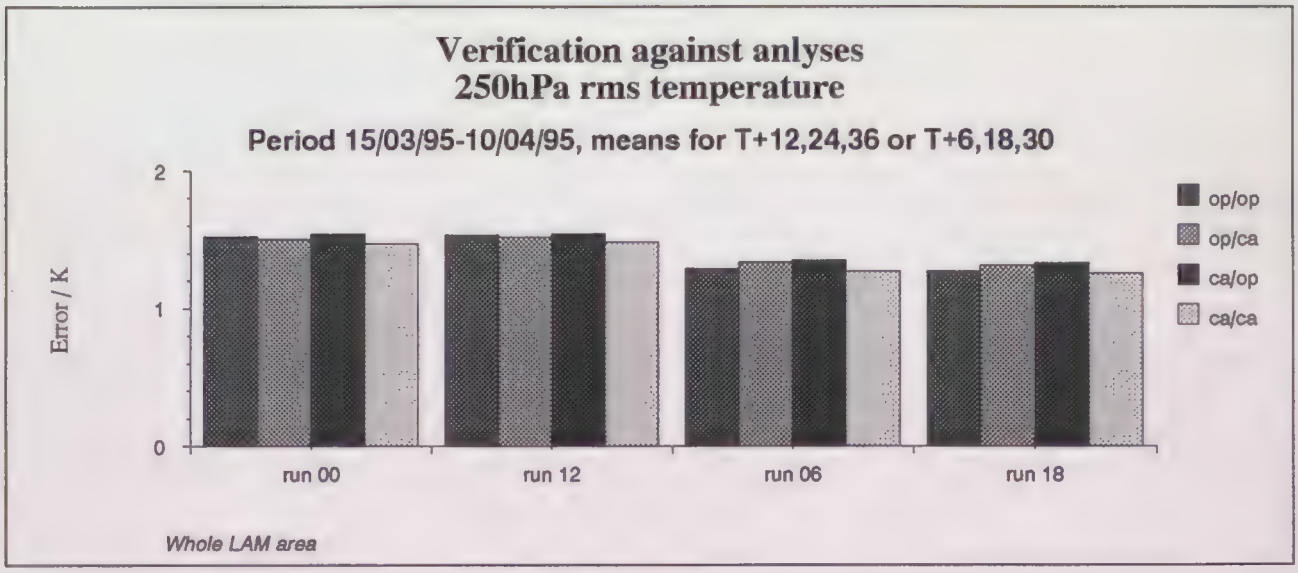

Verification against anlyses
PMSL rms error
Period 15/03/95-10/04/95, means for T+12,24,36 or T+6,18,30
Error / Pa
300
200
100
0
run 00
run 12
run 06
run 18
op/op
op/ca
ca/op
ca/ca
Whole LAM area

Figure 4.7


Verification against anlyses
250hPa rms temperature
Period 15/03/95-10/04/95, means for T+12,24,36 or T+6,18,30
Error / K
2
1
0
run 00
run 12
run 06
run 18
op/op
op/ca
ca/op
ca/ca
Whole LAM area

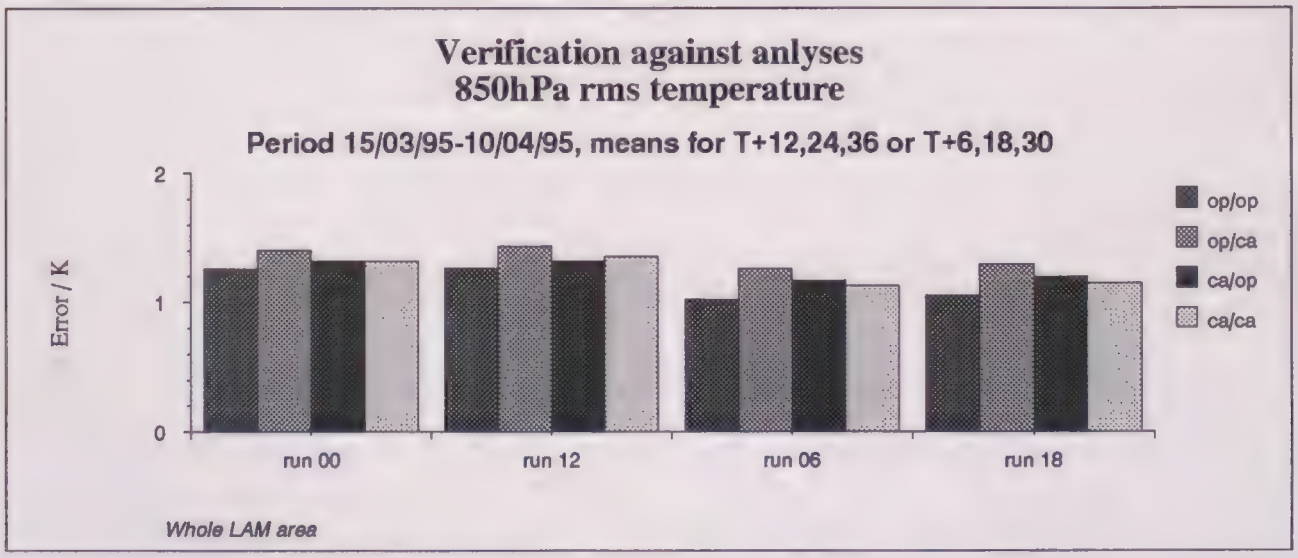
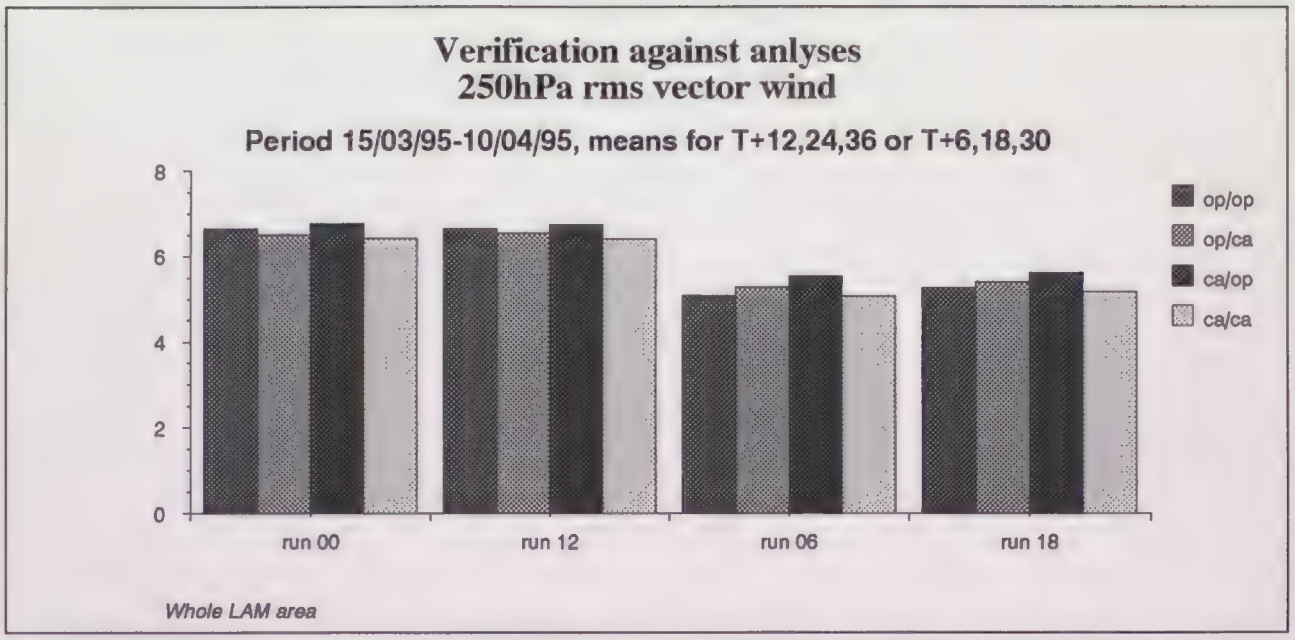

Verification against anlyses
850hPa rms temperature
Period 15/03/95-10/04/95, means for T+12,24,36 or T+6,18,30
Error / K
2
1
0
run 00
run 12
run 06
run 18
op/op
op/ca
ca/op
ca/ca
Whole LAM area

Figure 4.8


Verification against anlyses
250hPa rms vector wind
Period 15/03/95-10/04/95, means for T+12,24,36 or T+6,18,30
8
6
4
2
0
run 00
run 12
run 06
run 18
op/op
op/ca
ca/op
ca/ca
Whole LAM area

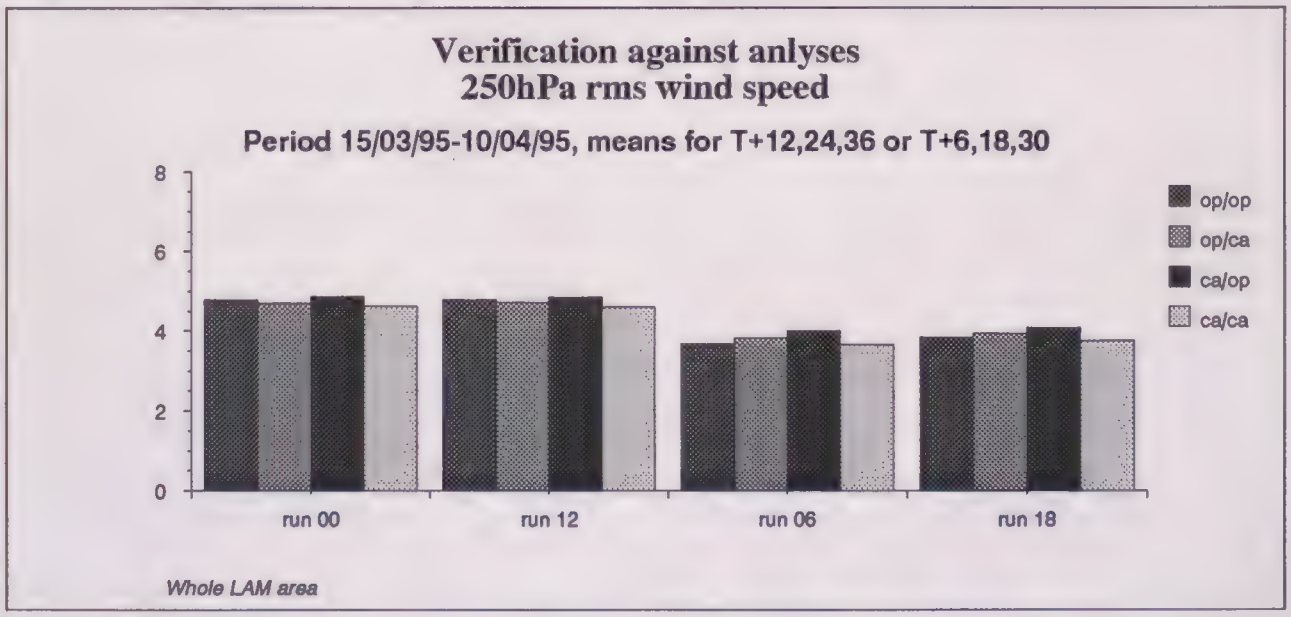

Verification against anlyses
250hPa rms wind speed
Period 15/03/95-10/04/95, means for T+12,24,36 or T+6,18,30
8
6
4
2
0
run 00
run 12
run 06
run 18
op/op
op/ca
ca/op
ca/ca
Whole LAM area

Figure 4.9

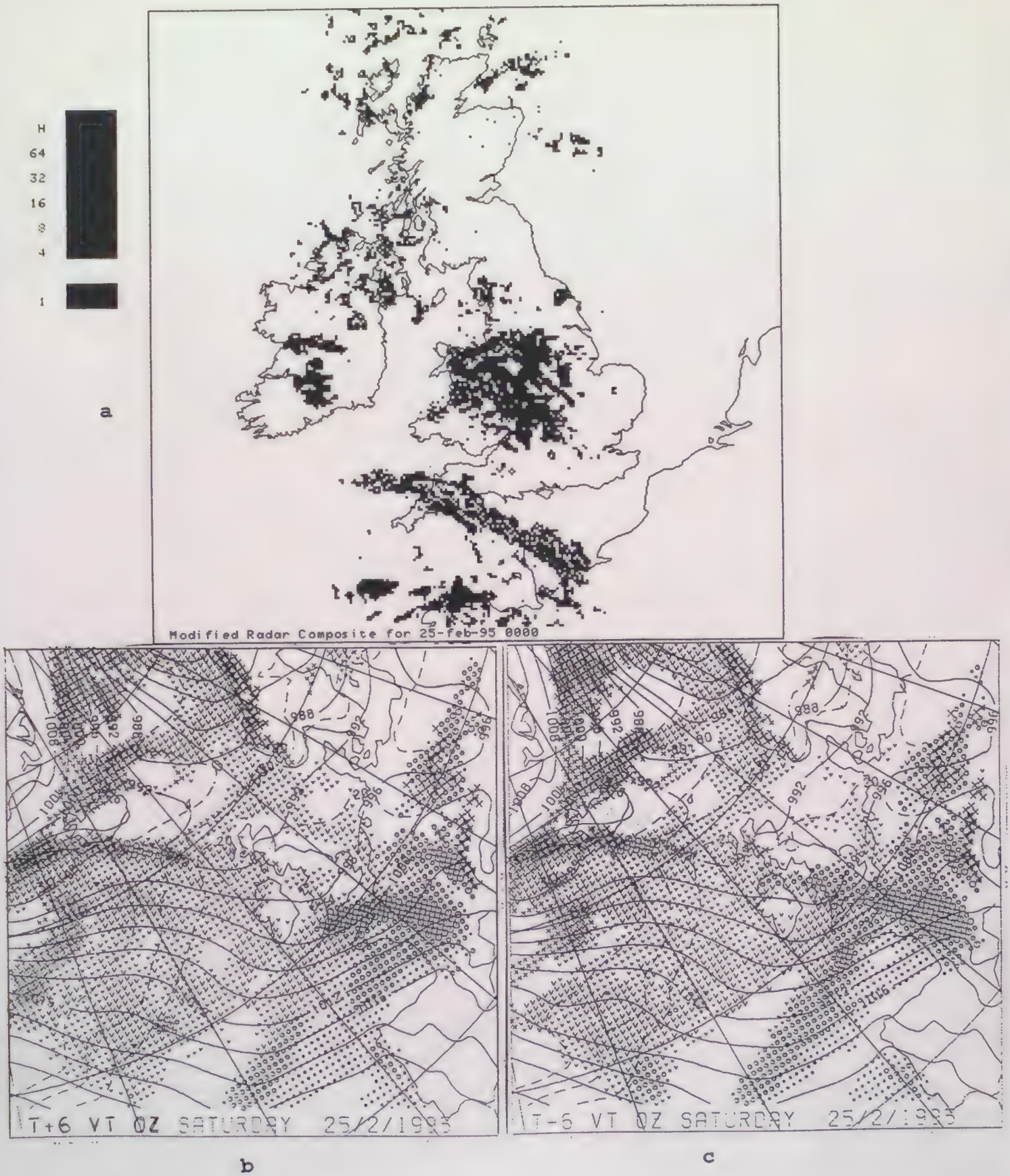
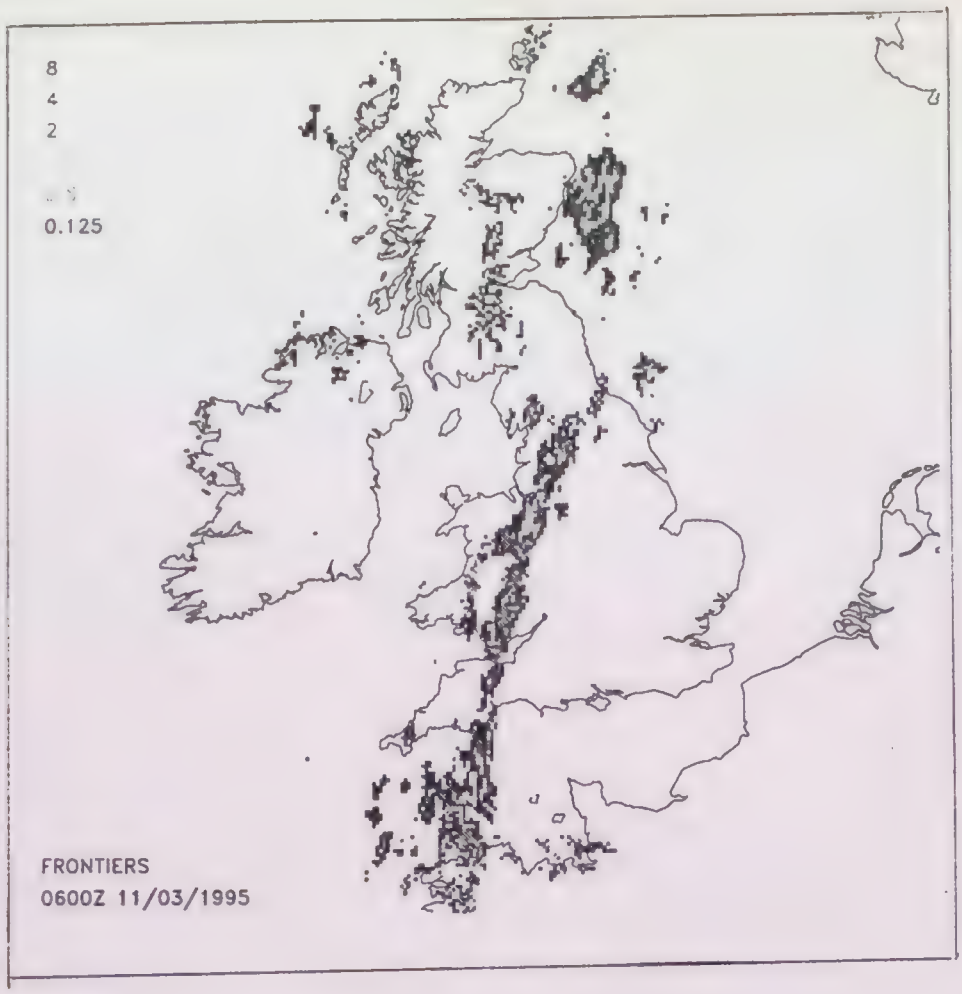


FIGURE 5.1
a) RADAR IMAGE FOR 00Z 25/02/95
T+06 TOTAL PRECIPITATION RATE AND MEAN SEA LEVEL PRESSURE FORECAST FOR 00Z 25/02/95
b) OPERATIONAL
c) CONTINUOUS ASSIMILATION TRIAL



a

b

c

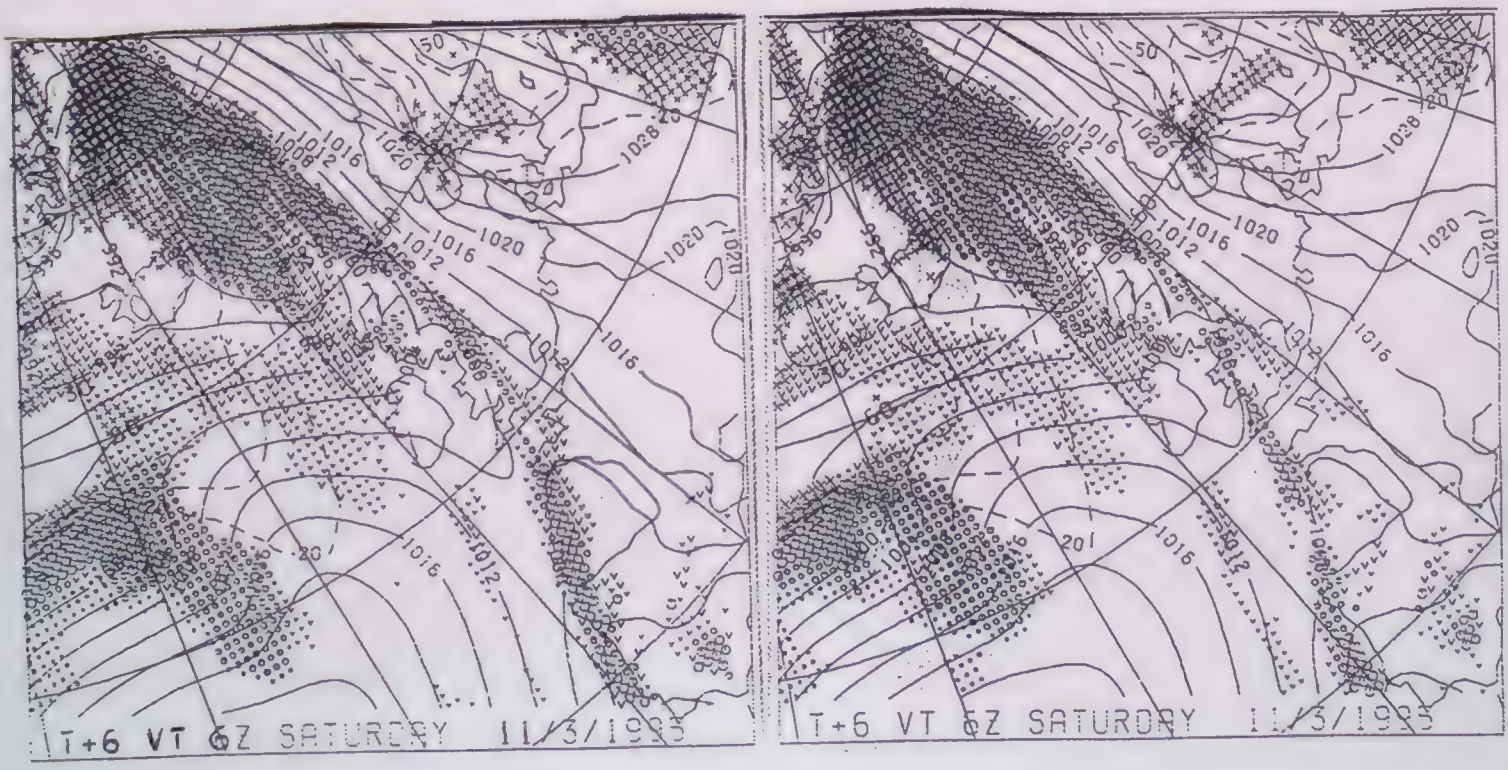


FIGURE 5.2

a) RADAR IMAGE FOR 06Z 11/03/95

T+06 TOTAL PRECIPITATION RATE AND MEAN SEA LEVEL PRESSURE FORECAST FOR 06Z 11/03/95

b) OPERATIONAL

c) CONTINUOUS ASSIMILATION TRIAL

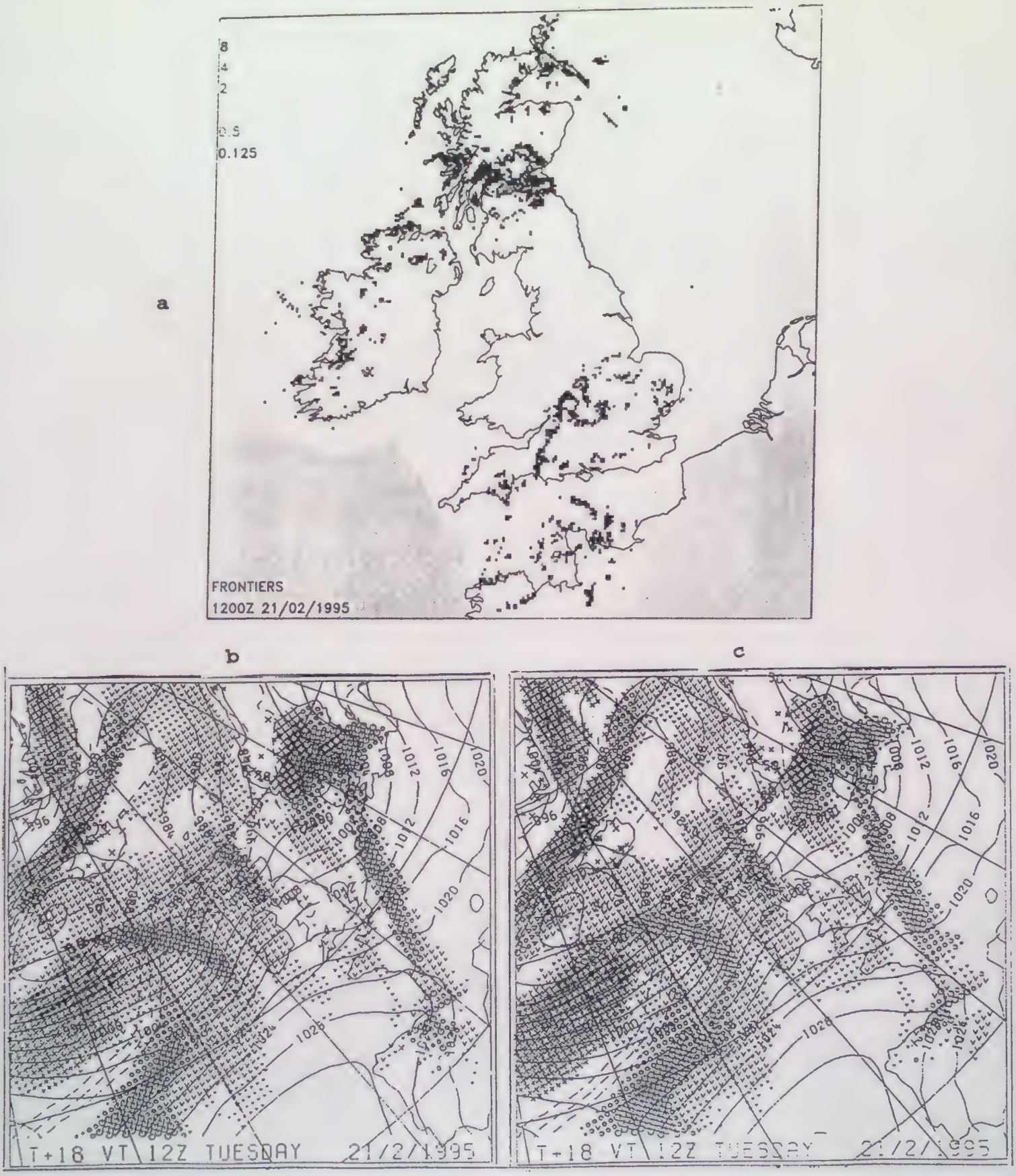


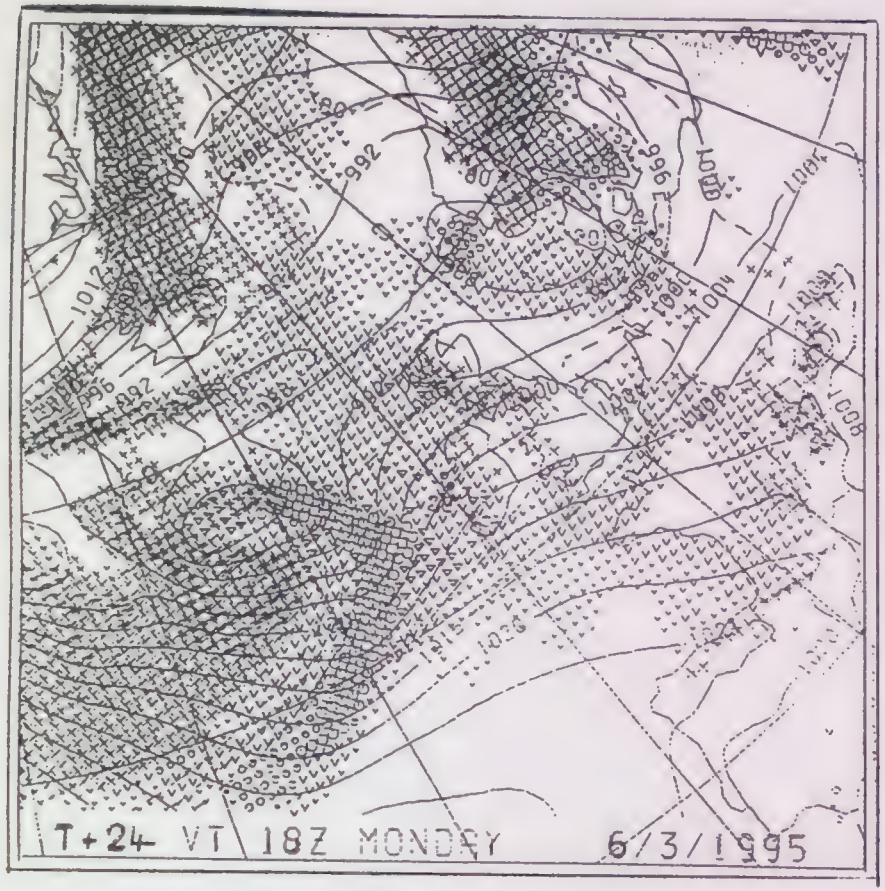
FIGURE 5.3

a) RADAR IMAGE FOR 12Z 21/02/95

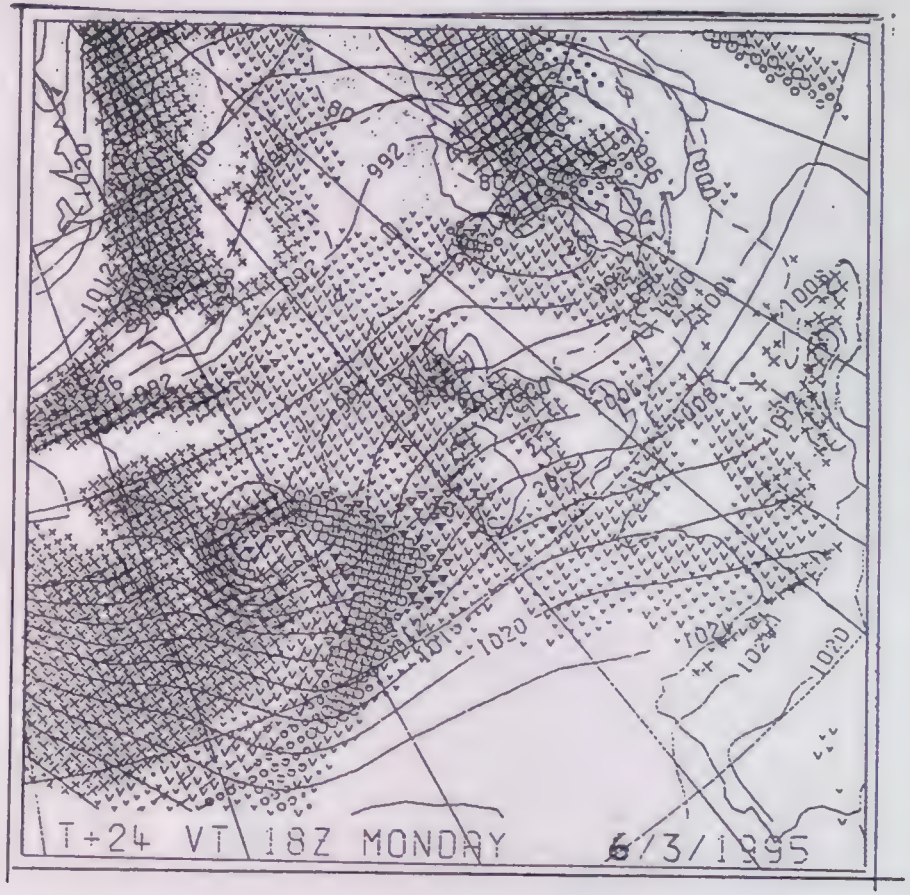
T+18 TOTAL PRECIPITATION RATE AND MEAN SEA LEVEL PRESSURE FORECAST FOR 12Z 21/02/95

b) OPERATIONAL

c) CONTINUOUS ASSIMILATION TRIAL

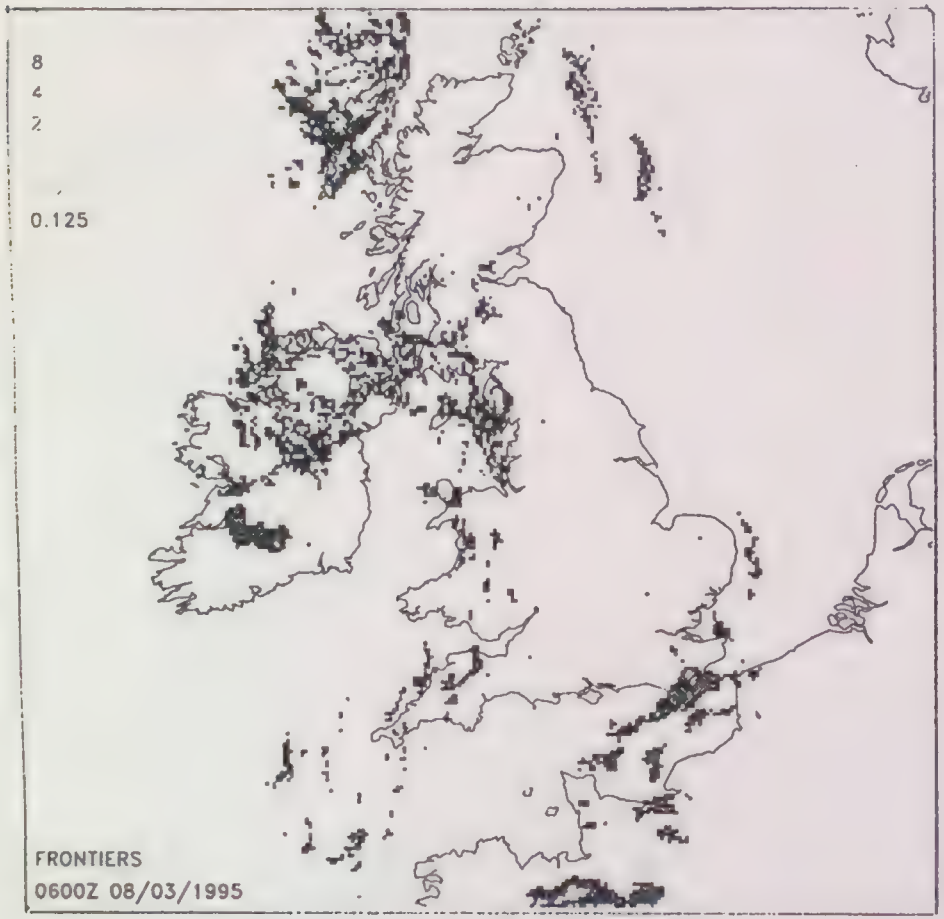


a

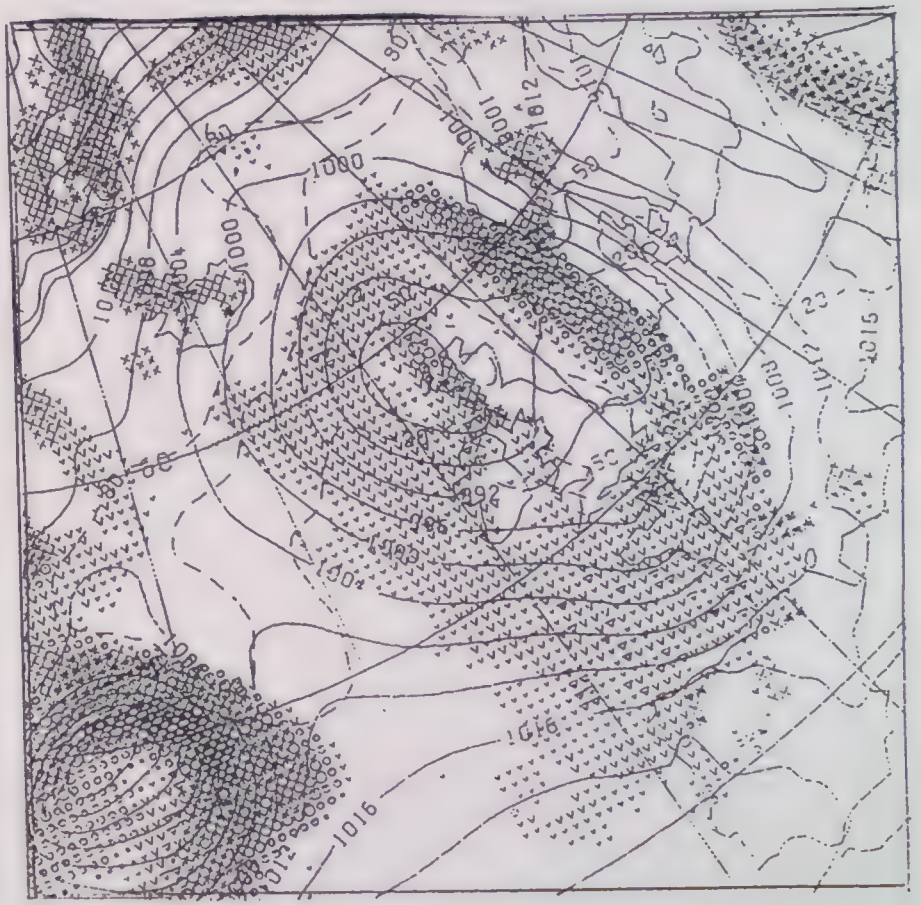


b

FIGURE 5.4
T+24 TOTAL PRECIPITATION RATE AND MEAN SEA LEVEL PRESSURE FORECAST FOR 18Z 06/03/95
a) OPERATIONAL
b) CONTINUOUS ASSIMILATION TRIAL

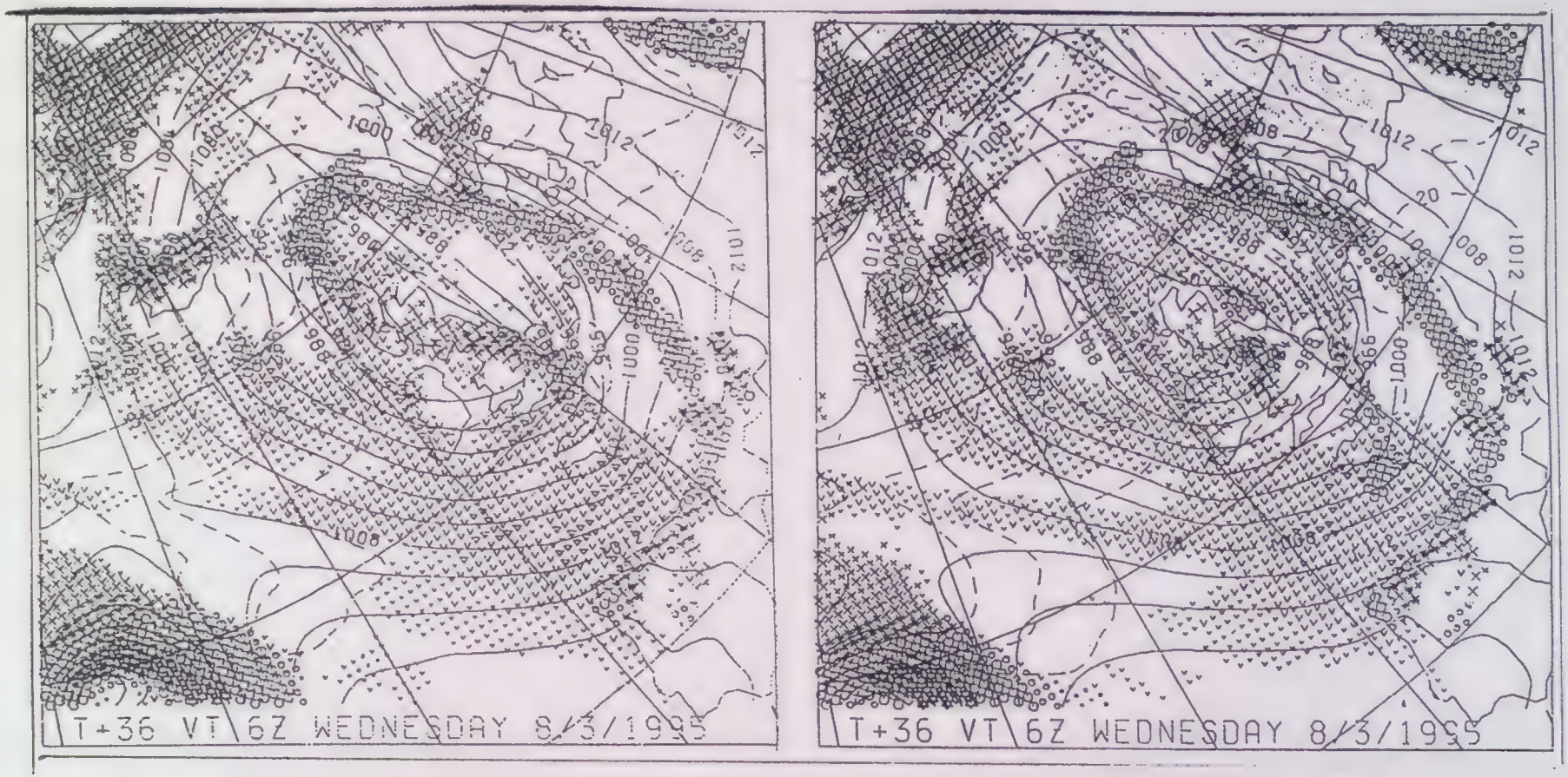


a



b

FIGURE 5.5
a) RADAR IMAGE FOR 06Z 08/03/95
MEAN SEA LEVEL PRESSURE ANALYSIS FOR 06Z 08/03/95
b) OPERATIONAL



a b

FIGURE 5.6
T+36 TOTAL PRECIPITATION RATE AND MEAN SEA LEVEL PRESSURE FORECAST FOR 06Z 08/03/95
a) OPERATIONAL
b) CONTINUOUS ASSIMILATION TRIAL

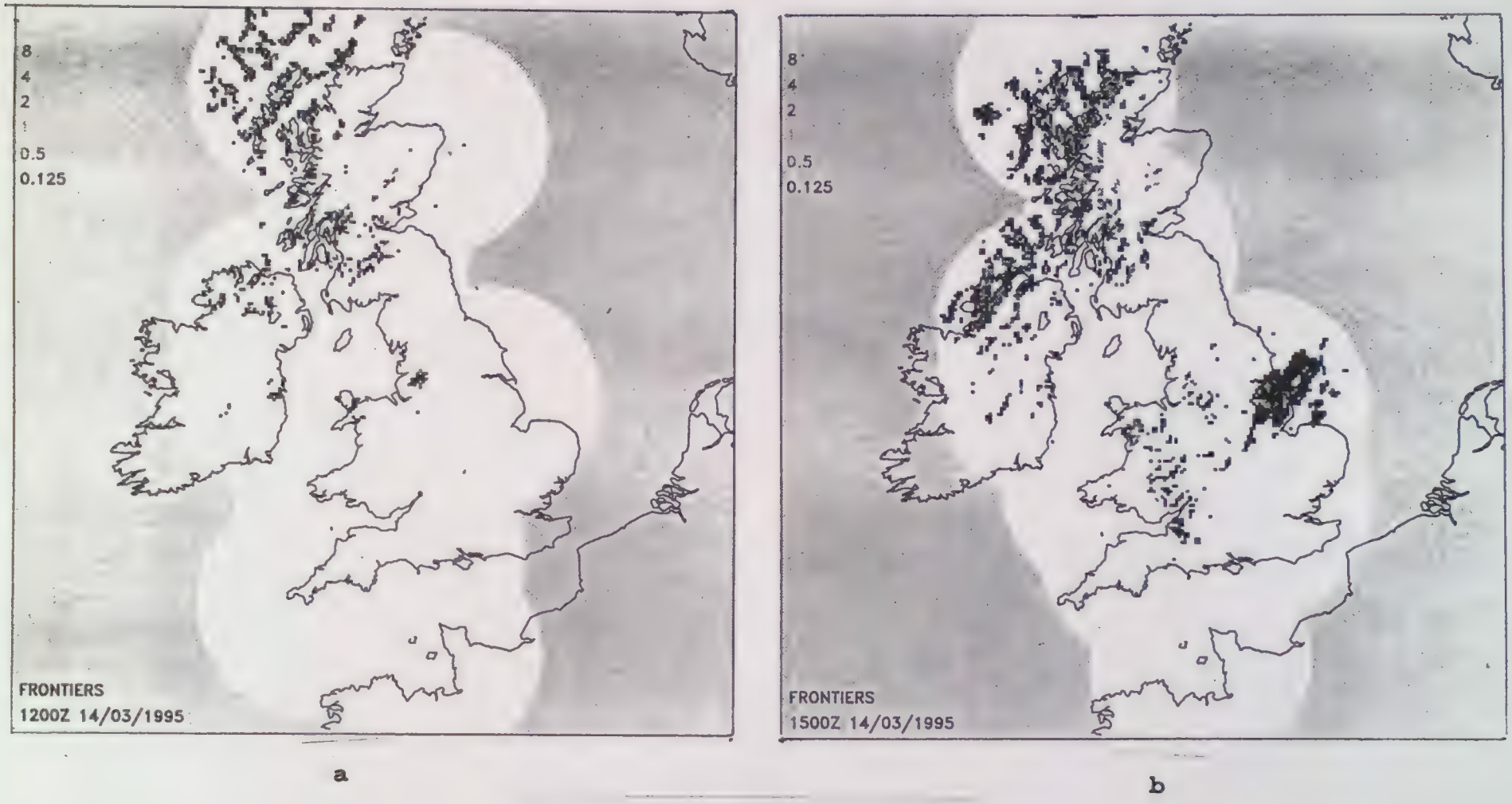
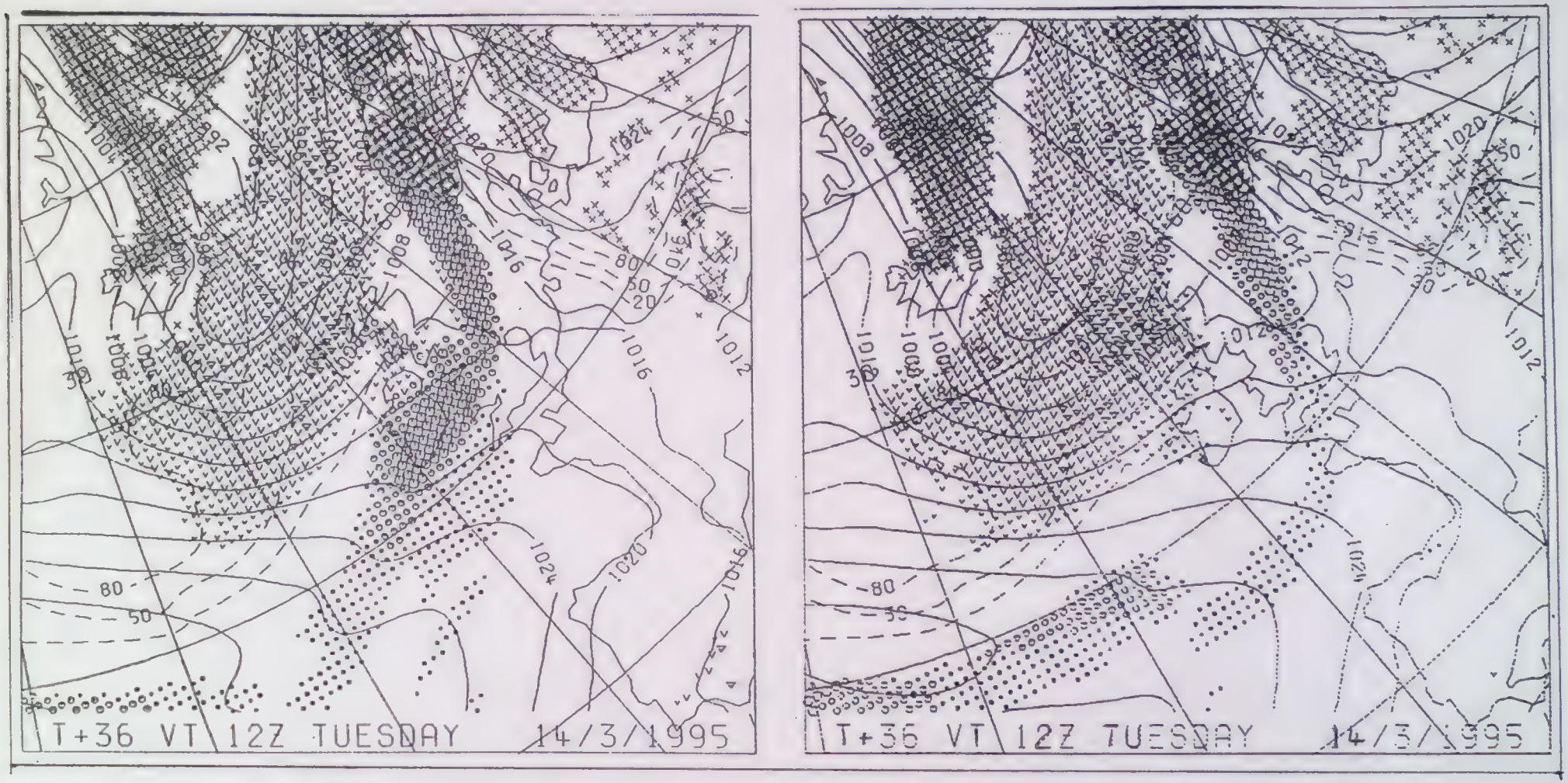


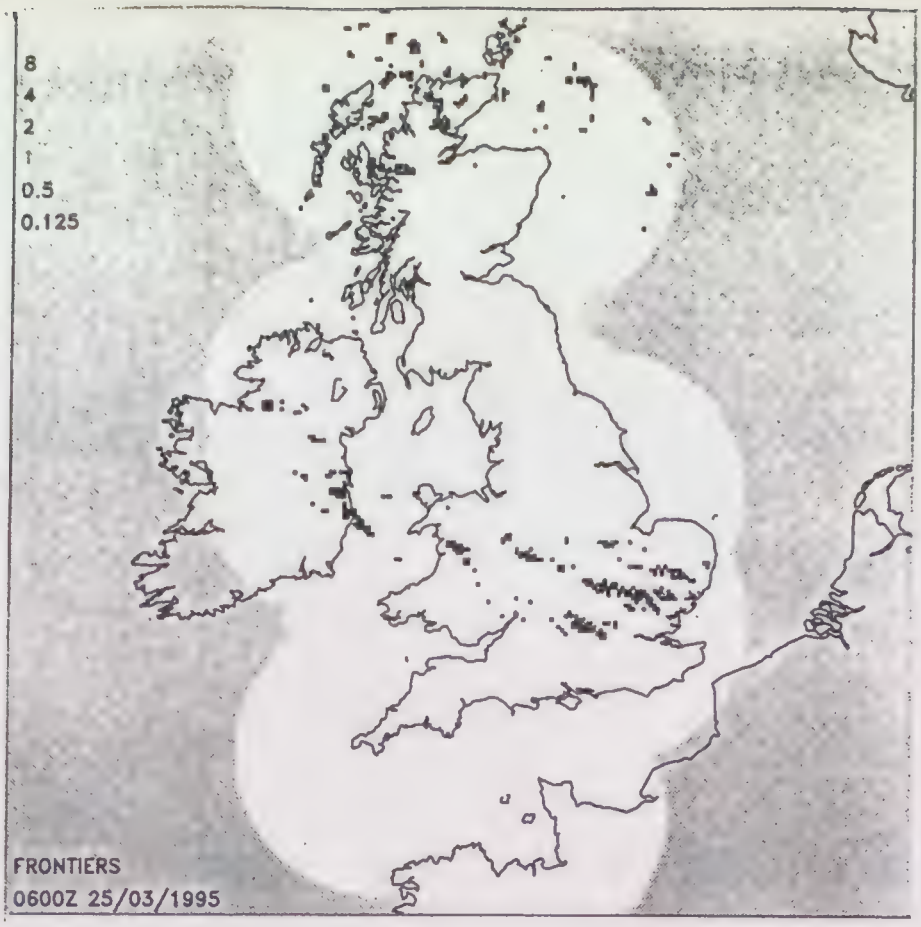
FIGURE 5.7
a) RADAR IMAGE FOR 12Z 14/03/95
b) RADAR IMAGE FOR 15Z 14/03/95



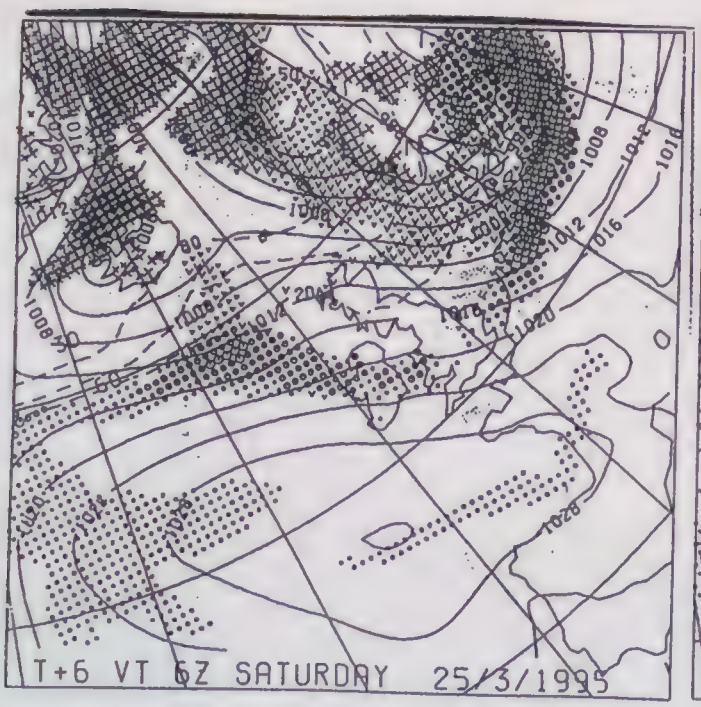
a b

FIGURE 5.8
T+36 TOTAL PRECIPITATION RATE AND MEAN SEA LEVEL PRESSURE FORECAST FOR 12Z 14/03/95
a) OPERATIONAL
b) CONTINUOUS ASSIMILATION TRIAL

a



b



c

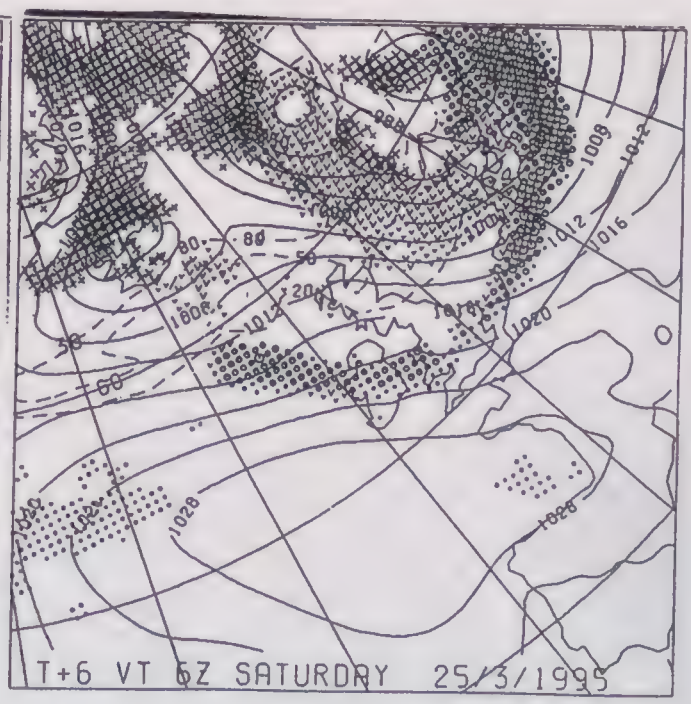


FIGURE 5.9
a) RADAR IMAGE FOR 06Z 25/03/95
T+06 TOTAL PRECIPITATION RATE AND MEAN SEA LEVEL PRESSURE FORECAST FOR 06Z 25/03/95
b) OPERATIONAL
c) CONTINUOUS ASSIMILATION TRIAL

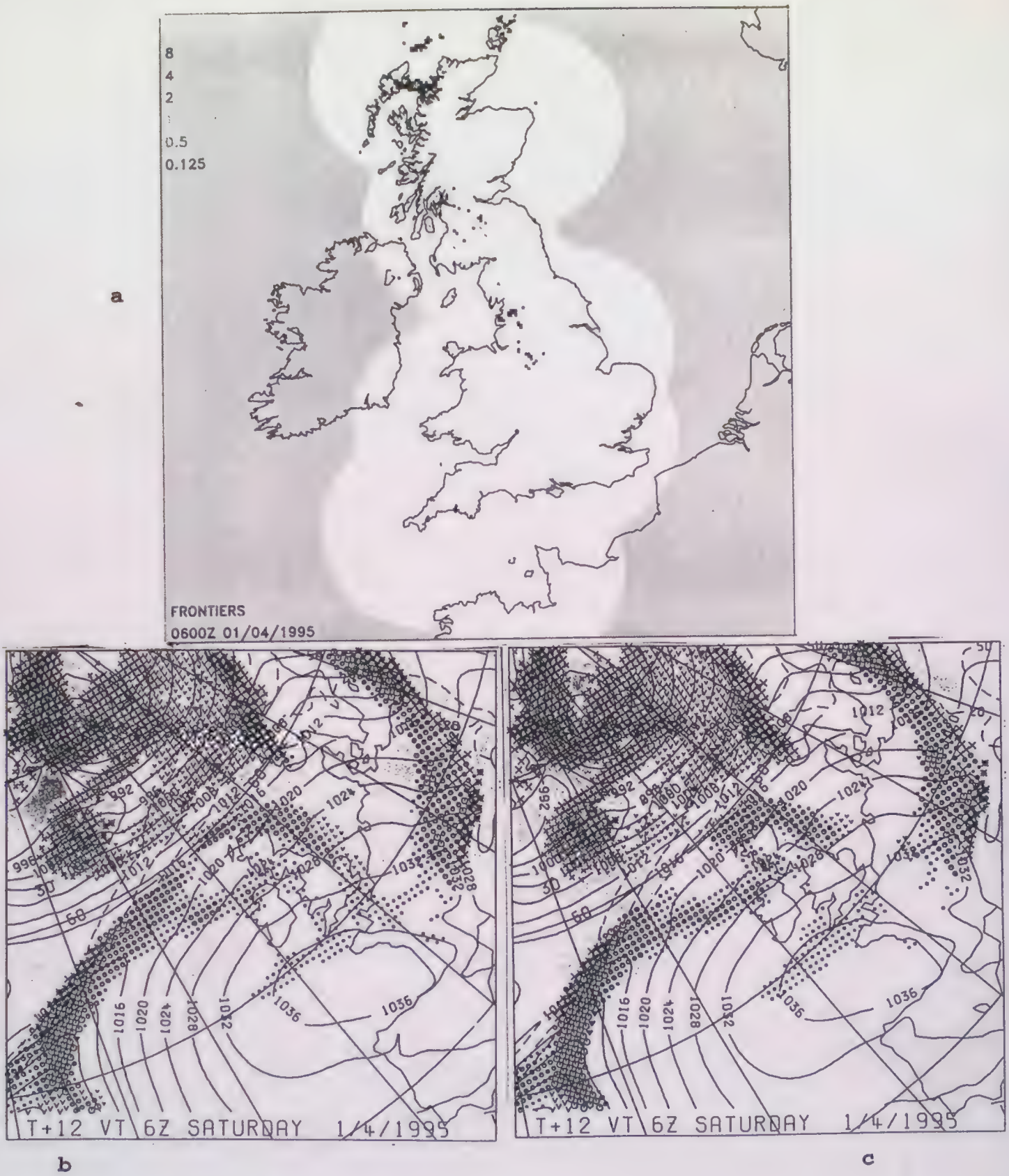


FIGURE 5.10
a) RADAR IMAGE FOR 06Z 01/04/95
T+12 TOTAL PRECIPITATION RATE AND MEAN SEA LEVEL PRESSURE FORECAST FOR 06Z 01/04/95
b) OPERATIONAL
c) CONTINUOUS ASSIMILATION TRIAL

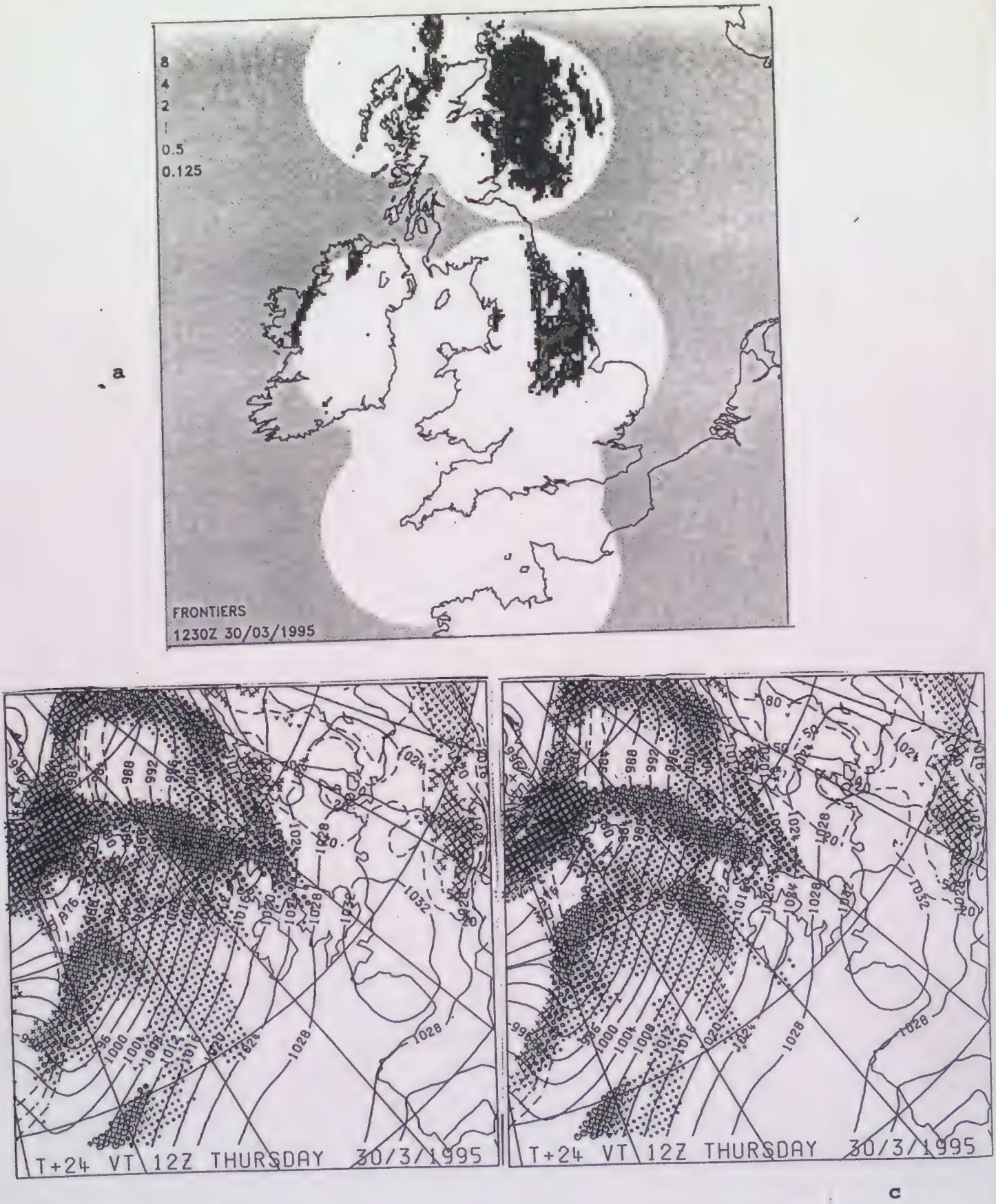


FIGURE 5.11
a) RADAR IMAGE FOR 1230Z 30/03/95
T+24 TOTAL PRECIPITATION RATE AND MEAN SEA LEVEL PRESSURE FORECAST FOR 12Z 30/03/95
b) OPERATIONAL
c) CONTINUOUS ASSIMILATION TRIAL

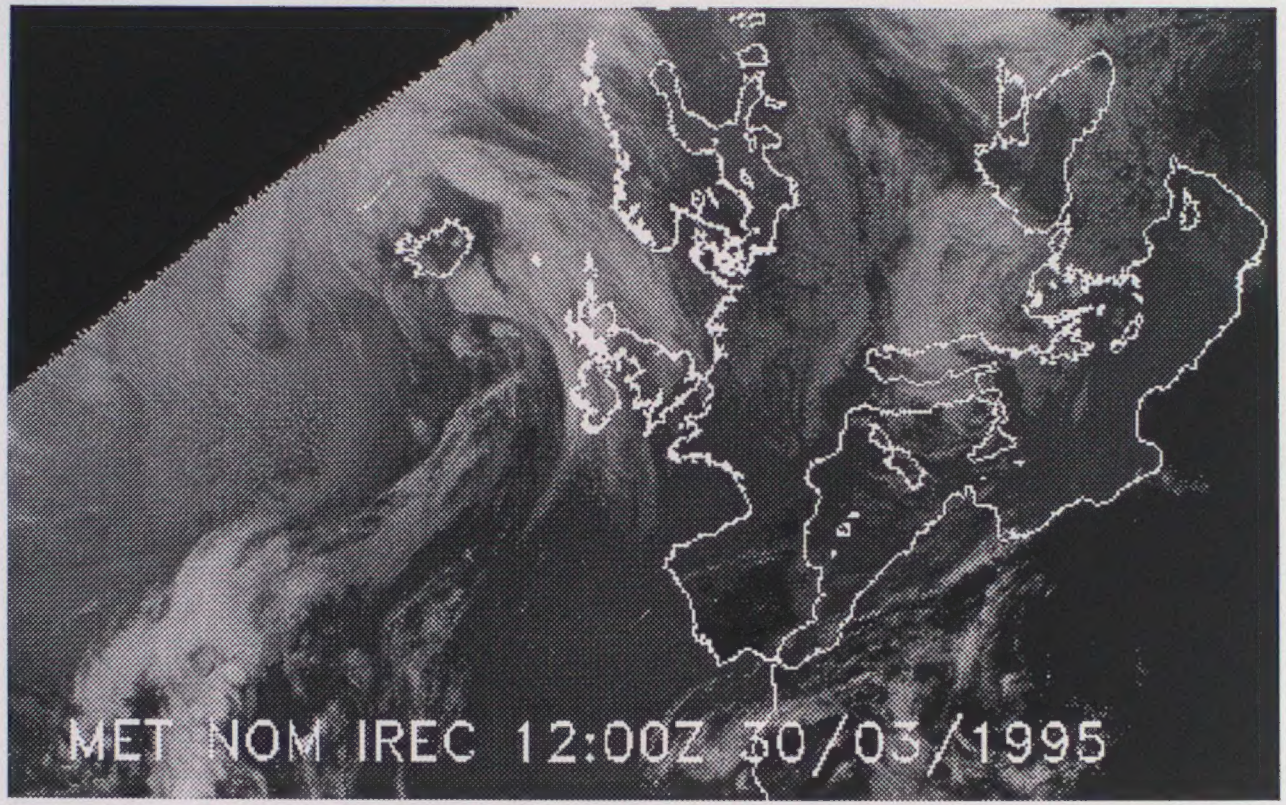
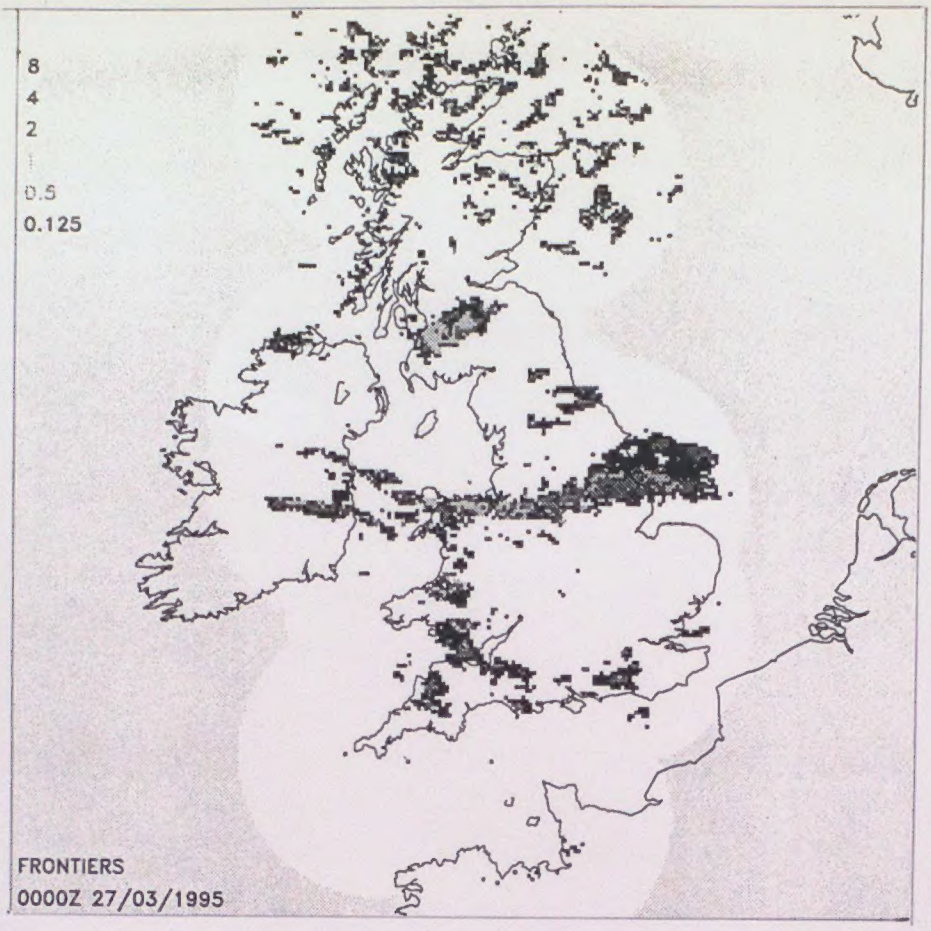
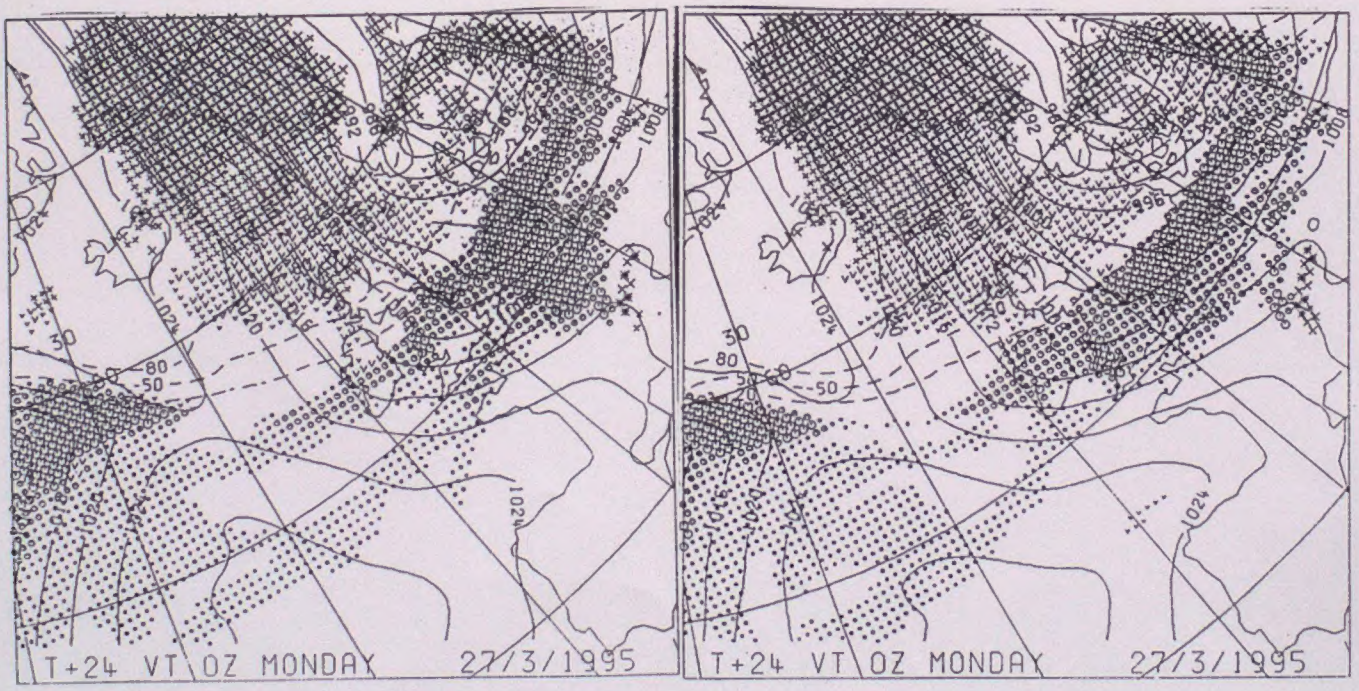


FIGURE 5.12
METEOSAT INFRA-RED SATELLITE IMAGE FOR 12Z 30/03/95



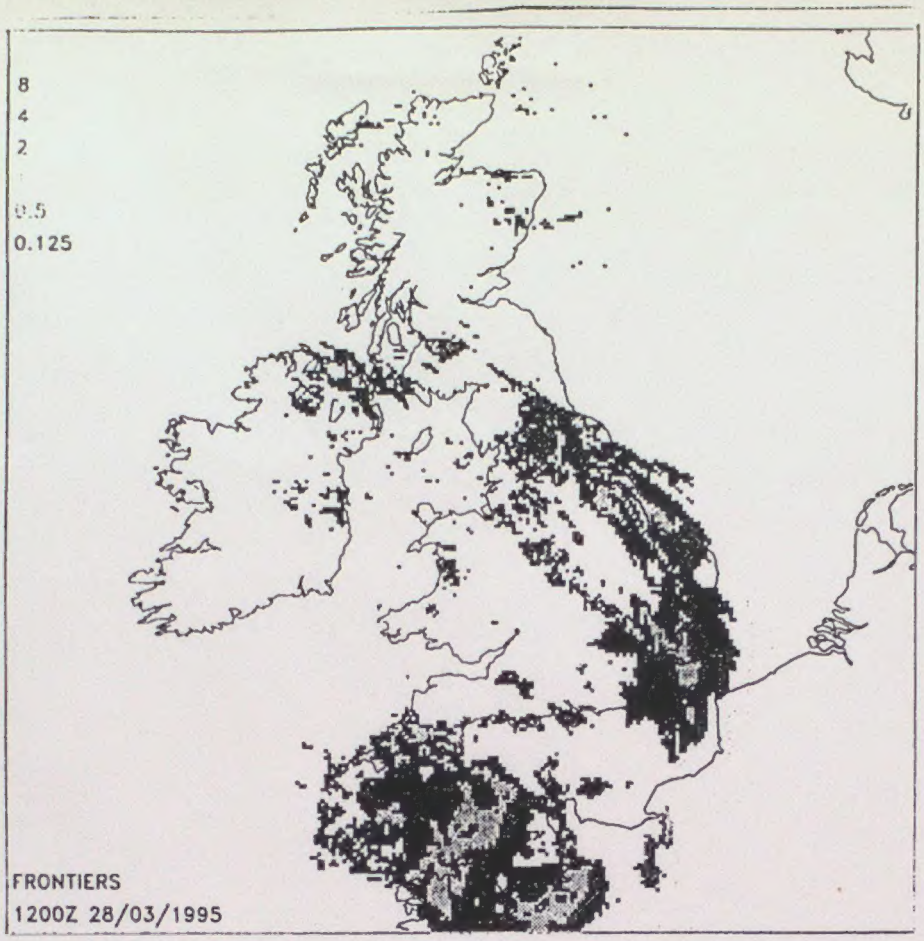
a



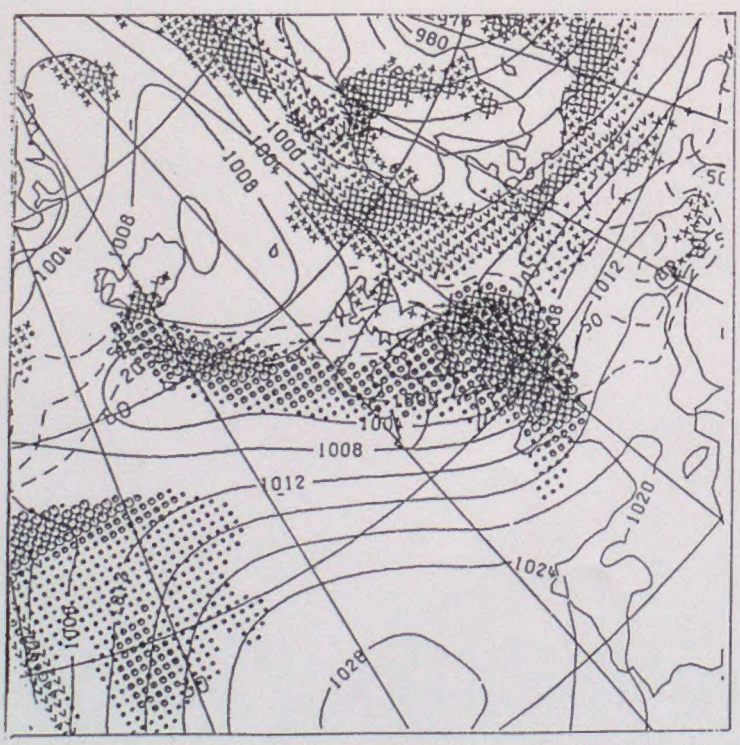
b c

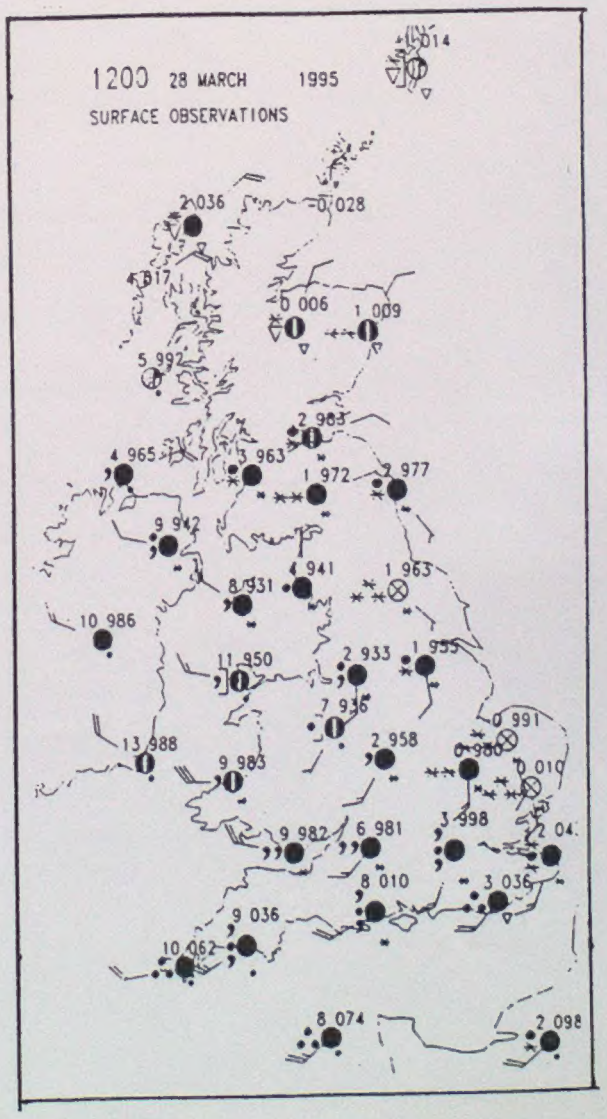
FIGURE 5.13
a) RADAR IMAGE FOR 00z 27/03/95
T+24 FORECAST OF MEAN SEA LEVEL PRESSURE AND TOTAL PRECIPITATION RATE VERIFYING AT 00z 27/03/95
b) OPERATIONAL
c) CONTINUOUS ASSIMILATION TRIAL

a



b





c

FIGURE 5.14
a) RADAR IMAGE FOR 12z 28/03/95
b) OPERATIONAL MEAN SEA LEVEL PRESSURE ANALYSIS FOR 12Z 28/03/95
c) OBSERVATIONS FOR 12z 28/03/95

a

b

FIGURE 5.15
T+30 FORECAST OF MEAN SEA LEVEL PRESSURE AND TOTAL PRECIPITATION RATE VERIFYING AT 12z 28/03/95
a) OPERATIONAL
b) CONTINUOUS ASSIMILATION TRIAL